AEROGRAPHER'S MATE THIRD CLASS (OBSERVER)

NAVAL EDUCATION AND TRAINING COMMAND

RATE TRAINING MANUAL AND NONRESIDENT CAREER COURSE

NAVEDTRA 10369

Although the words "he," "him," and "his" are used sparingly in this manual to enhance communication, they are not intended to be gender driven nor to affront or discriminate against anyone reading *Aerographer's Mate Third Class*, NAVEDTRA 10369.

Naval Education And Training Program Development Center

AEROGRAPHER'S MATE THIRD CLASS (OBSERVER)

NAVEDTRA 10369

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PREFACE

This rate training manual is one of a series of training manuals prepared for enlisted personnel of the Navy and Naval Reserve who are studying for advancement in the Aerographer (AG) rating. As indicated by the title, this manual is based upon the professional qualifications for the rate of AG3, as set forth in the *Manual of Qualifications for Advancement*, NAVPERS 18068 (Series).

An NRCC (Nonresident Career Course) is included with this manual. Information on course administration and ordering is available in NAVEDTRA 10061.

This manual was prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training.

Your suggestions and comments on this manual are invited. Address them to Commanding Officer, Code PD, NETPDC, Pensacola, FL 32509.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

AEROGRAPHER'S MATE THIRD CLASS

OCCUPATIONAL STANDARDS

NUMBER	OCCUPATIONAL STANDARDS	UNIT/LESSON
46 PUBLICATIONS		
46006	USE PUBLICATIONS AND DIRECTIVES	3/1
85 ENVIRONMENTAL PREDICTION SYSTEMS AND SERVICES		
85246	IDENTIFY, ENCODE AND DECODE METEOROLOGICAL AND OCEANOGRAPHIC DATA	3/1
85247	OPERATE AND PERFORM ROUTINE CHECKS, OPERATOR'S PREVENTIVE MAINTENANCE AND LIMITED CALIBRATIONS AND ADJUSTMENTS ON METEOROLOGICAL AND OCEANOGRAPHIC EQUIPMENT AND INSTRUMENTS	5/1, 5/2, 5/3, 5/4
85250	OBSERVE SURFACE METEOROLOGICAL ELEMENTS, AND COLLECT, RECORD AND PREPARE FOR TRANSMISSION SURFACE METEOROLOGICAL OBSERVATIONS	1/1, 1/2, 1/3, 1/4, 2/1
85251	RECORD AND TRANSMIT PILOT REPORTS	1/4
85252	PLOT SYNOPTIC SURFACE CHARTS	3/2
85253	PLOT SURFACE CHARTS USING AVIATION OBSERVATIONS	3/2
85254	PLOT CONSTANT PRESSURE CHARTS	3/4
85255	PLOT AND ANALYZE SKEW T, LOG P DIAGRAMS	3/3
85256	PLOT DATA FROM NAVY FALLOUT WARNING AND PRE-BURST PREDICT MESSAGES	3/5, 3/7
85257	PLOT DATA FROM ENVIRONMENTAL WARNINGS AND ADVISORIES	3/7
85258	DETERMINE AND PLOT SATELLITE TRACKS FROM METEOROLOGICAL SATELLITE PREDICT MESSAGES	3/6
85259	APPLY GRID TO METEOROLOGICAL SATELLITE PICTURES	3/6

NUMBER	OCCUPATIONAL STANDARDS	UNIT/LESSON
85 ENVIRONMENTAL PREDICTION SYSTEMS AND SERVICES		
85303	SORT, DISPLAY AND FILE INCOMING TELETYPE AND FACSIMILE DATA	4/1, 4/2
85305	PLOT SEA SURFACE TEMPERATURE AND BATHYTHERMOGRAPH DATA	3/5
85306	PREPARE ACOUSTIC PRODUCT REQUEST (APR) MESSAGES FOR TRANSMISSION	6/1
86 COMMUNICATIONS		
86272	OPERATE COMMUNICATIONS EQUIPMENT	5/3, 6/2
86316	OPERATE NAVAL ENVIRONMENTAL DISPLAY STATION	6/3

UNIT 1

SURFACE OBSERVATIONS

FOREWORD

This unit introduces you to the basics of observing, recording, and transmitting Surface Observations.

There are four lessons in this unit. The first three lessons are presented in the order that the subject matter appears on the observation form. Lesson 1 covers Sky Condition and Visibility. The elements, techniques, and criteria for reporting them. Lesson 2 lists the classification and procedures for reporting Weather and Obstructions to Vision. Reporting the individual elements of Pressure, Temperature, and Wind make up Lesson 3. Lesson 4 deals with the exact criteria for reporting as a Record, Special, or Local the Types of Surface Observations as well as techniques used when reporting from a ship.

UNIT 1—LESSON 1

SKY CONDITION AND VISIBILITY

OVERVIEW

Identify the meteorological elements (that relate to Sky Condition and Visibility) and the procedures related to collecting, recording, and preparing surface meteorological observations for transmission.

OUTLINE

State of the Sky

Orographic Cloud Forms

Cloud Code Group

Sky Condition

Ceilings

Ceiling/Sky Remarks and Entries

Cloud Height Measuring Equipment

Visibility

SKY CONDITION AND VISIBILITY

The evaluation of clouds and visibility is probably the most involved and significant part of taking a weather observation. As an observer, you must be able to identify 27 states of the sky and understand how each affects the weather. In many cases, your interpretation and evaluation of the sky condition and visibility determines whether an aircraft can land at your air station or whether the pilot must seek an alternate landing field.

Learning Objective: Identify the meteorological elements (that relate to Sky Condition and Visibility) and the Procedures related to collecting, recording, and preparing surface meteorological observations for transmission.

STATE OF THE SKY

Have you ever looked up at the clouds in the sky and remarked, "It looks like rain?" Clouds have been called the signposts of weather. Clouds occurring in sequence describe a weather event much as chapters of a book unfold a story. For instance, the changes from cirrus to cirrostratus to altostratus clouds warn of an approaching warm front.

These cloud *messages* are not hard to understand, but they are not obvious. To become a good cloud reader takes study and experience. To interpret clouds we should consider their formation and classification. Experienced meteorologists categorize all clouds into 10 basic types. These basic types are:

1. Cumulus
2. Cumulonimbus
3. Stratocumulus

4. Stratus
5. Altostratus
6. Nimbostratus
7. Altocumulus
8. Cirrus
9. Cirrostratus
10. Cirrocumulus.

Each basic type may be further classed into subtypes.

The subtypes are recognized internationally as 27 states of the sky—arranged as low, middle, and high clouds. Each state of sky possesses a distinguishing feature to separate it from the others. This feature may be the appearance, extent, size, or method of formation. The distinguishing features provide the clues that preview approaching weather. Low clouds are the first subtype discussed.

Learning Objective: Name the appropriate low cloud classification for given cloud descriptions and characteristics.

Cumulus (CU)

In the year 1803, an English pharmacist, Luke Howard, divided all clouds into three basic groups—cumulus, stratus, and cirrus. Cumulus, translated from Latin, means "heap." Heap aptly describes this cloud in most of its stages. In the earliest stage of development, cumulus usually forms in, and indicates, good weather. A typical cumulus cloud is shown in figure 1-1-1. In this figure the letters A, B, and C are used to point out the different features of the cumulus cloud. "A" shows that cumulus has a clearly defined outline during the building stage and appears very white in color. Note the bulging appearance characteristic of the building stage. "B" shows that the base of the cumulus becomes darker as the cloud builds in size, but generally the base remains horizontal. After the building stage has gone on for a while or ended, the edges of cumulus become ragged, being fragmented by the wind as shown in "C". Whatever its stage of

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Figure 1-1-1.—Cumulus.

development, cumulus always has the "cottony" appearance.

Since these clouds form by convective action, the height of their base above the earth's surface is related directly to the amount of moisture near the surface—the higher the moisture content, the lower the cloud base. Although the water droplets in cumulus are very numerous, they are also very small in the cloud's early stages. As the cloud grows in size, large drops within the cloud increase in number. The large drops may be precipitated from the cloud or may continue to be carried within the cloud by vertical air motions. Precipitation in the form of showers occurs with cumulus clouds of moderate development. Though this precipitation may be of moderate intensity, its duration is usually short-lived. These clouds do not produce the heavy rain and high winds that are associated with their bigger brothers, the cumulonimbus. Occasionally, the precipitation (showers) from cumulus clouds evaporates before it reaches the ground. This situation is referred to as *virga* and is characterized by a dark area immediately below the nearly uniform base of the cumulus cloud. This darkness, caused by precipitation, decreases in intensity as it descends beneath the cloud until it disappears (complete evaporation). When virga, consisting of snow or ice crystals occurs, the virga portion is not as dark, and it appears more wispy. This is caused by the greater influence that wind has on falling snow and appears as a

greater bending of the precipitation trails (virga). In any case, the precipitation does not reach the surface. There are two subtypes of cumulus for coding.

C_L-1 (CUMULUS).—Cumulus clouds encoded as low cloud "1" have *little vertical extent*, may appear flattened, and is associated with good weather conditions (no precipitation). This cloud is shown in foldout 1-1-1 (appearing at the end of this lesson) as L1, cumulus humilis. When this cloud occurs below cumulonimbus or nimbostratus during precipitation, it is coded as L7. Under these conditions, it usually appears ragged, changes shape rapidly, and is called cumulus fractus. Thus, the primary difference in classification of L1 and L7 is precipitation. When the convective forces that form cumulus continue their action, L1 cumulus grows into L2 cumulus.

C_L-2 (CUMULUS).—Low cloud "2" is a cumulus cloud of moderate or strong (*towering*) vertical development. Generally, C_L-2 is accompanied by other cumulus or stratocumulus clouds. All of these clouds have their bases at the same level. When this cloud type develops a tower appearance, illustrated in the first L2 picture of foldout 1-1-1, you should enter a remark in your observation as TCU W ("W" showing the direction from station). Towering cumulus may be distinguished from cumulonimbus by a lack of massiveness—i.e., its strong vertical growth is NOT matched by a horizontal spreading or bulging. Other important things to remember about this type are that it does not have a cirriform top, and it is rarely capable of producing thunder. Cumulus clouds of moderate or strong vertical extent may, however, produce precipitation in the form of showers. When a cumulus develops both height and massiveness, it enters the next basic cloud category, cumulonimbus.

Cumulonimbus (CB)

Energy forces within a cumulonimbus are capable of producing the most intense storm known in weather—the tornado. However, when cumulonimbus clouds are observed on the horizon, they appear strikingly beautiful. Their tall, rounded masses reach gracefully skyward, often penetrating above cirrus cloud formations. Overhead, they present a more menacing picture. It is not uncommon for these clouds to produce heavy rain, lightning, strong gusty surface winds, hail, and occasionally tornadoes.

To classify cumulonimbus clouds into the basic cloud forms, you should know that CB clouds are distinguished from cumulus clouds by the following characteristics:

- Massive appearance
- Extensive vertical development
- Fibrous or anvil top
- Thunder and lightning

Though the anvil feature of cumulonimbus is an identifying feature, sometimes only a fibrous appearance or a lack of a sharp top outline is observed. When the cloud enters the dissipation stage, this upper section invariably assumes the classic anvil formation. Figure 1-1-2 shows several interesting features. At callout A of this figure, the cloud shown with the anvil top is in the dissipating stage, as evidenced by the anvil itself. During dissipation, much of the cell's energy is directed downward. Consequently, surface weather may be even more severe during this stage. Callouts B and C show the fibrous appearance of a CB (cumulonimbus) top. At B, the cloud is just beginning to lose its sharp outline. At C, the fibrous appearance is evident. Callout D points to a cell of convective activity that shows the typical sharp outlines of a building cumulus. Often you may encounter a dissipating cell next to a building cell.

The question often discussed among observers is, when does the cumulus (moderate development) become cumulonimbus. There are several points of identification. When viewed from a distance, the massiveness and the appearance of the cloud top, already mentioned, offer positive means of CB identification. Overhead, other identifying guides are needed.

Thunder, lightning, or hail may be the sole indication of their presence. When you can't hear thunder overhead and are having trouble in deciding between nimbostratus or cumulonimbus,

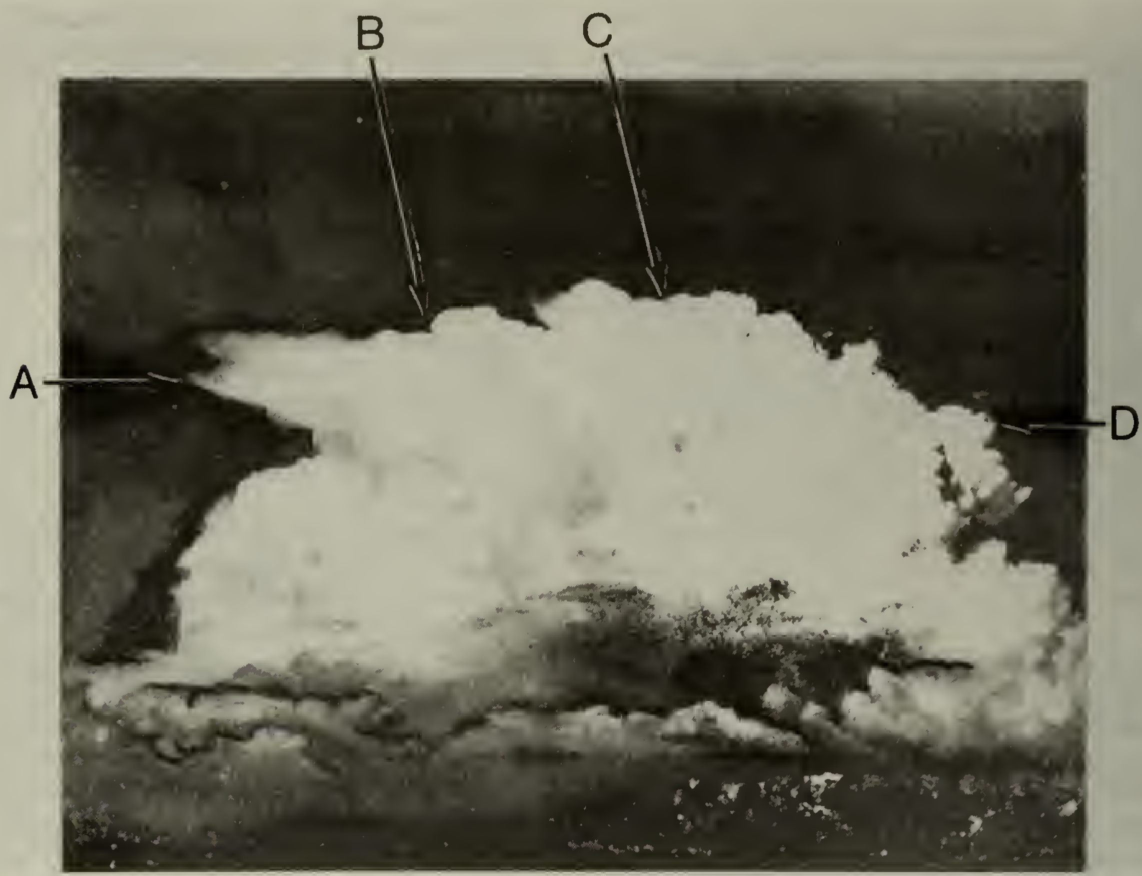

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Figure 1-1-2.—Cumulonimbus.

use the character (showery versus continuous) or the rain as a guide. A cumulonimbus cloud with extensive vertical development which has begun dissipating is generally preceded by an outrush of cool air a few minutes before the storm cell reaches overhead. (This is normally when the strongest surface wind gusts occur.) The dark lower portion of a CB is usually accompanied by rapid-moving stratus fractus and cumulus fractus. Usually one of these signs can identify a CB from a cumulus.

A common occurrence with cumulonimbus cloud varieties is mamniatus development. This feature normally occurs at the base of the cloud in the form of clearly defined bulges or pouches as shown in figure 1-1-3, but may appear at some level above the cloud base. In either case, these mammatus formations provide the forecaster with a good indication of the degree of instability present in the area. Though these cloud-types may not produce tornadic activity, they can be used by the forecaster as indicators of potentially severe weather.

Studies of tornado development reveal that the base of the cumulonimbus cloud usually appears to be very dark and ragged before tornado activity occurs. The first sign of a funnel cloud often appears in the form of a tuba (a small appendage, often cone-shaped) beneath the cloud. When tubas are sighted with a CB, they frequently appear and withdraw from several portions of the cloud. A tuba that continues to develop toward the ground is referred to as a funnel cloud until it reaches the

209.446

Figure 1-1-3.—Mammatus.

ground—then it becomes a tornado (waterspout over water). The passage of a CB can cause a variety of changes in weather. Observing and disseminating these conditions present a challenge. For coding purposes, two subtypes of CB exist.

C_L-3 (CUMULONIMBUS).—Low cloud type "3" is cumulonimbus in its earliest stage of development. A low "3" cloud differs from other CB clouds (type 9) because the summit lacks cirriform development (no anvil). Cumulonimbus clouds classified as L3 have summits which lack clear outlines but are neither clearly fibrous (cirriform) nor in the form of an anvil. L3 in foldout 1-1-1, shows an example of a cumulonimbus cloud without appreciable cirriform development. When you observe this type of cloud, add a remark to your observation to indicate the location (direction) of the cumulonimbus cloud from the station and the direction toward which it is moving.

The following are examples of cumulonimbus remarks entered in column 13 of Federal Meteorological Form 1-10, Surface Weather Observations (MF 1-10). (See A in Appendix V.)

- CB W MOVG E
- CB NE MOVG SE
- CB NW (This indicates that the direction of movement is unknown)
- CB 5NE MOVG E. (Enter distance (5) from station if it is known.)

These typical remarks for CB clouds are entered when no thunderstorm is being reported.

C_L-9 (CUMULONIMBUS).—Low cloud type "9" is distinguished from L3 by the presence of the cirriform anvil. If you find it difficult to determine whether the type is L3 or L9, the occurrence of lightning, thunder, or hail is customarily associated with L9. An L9 cloud requires a remark in column 13 of MF 1-10 that is similar to that for L3 clouds. When mammatus development is present, use the same remark format in column 13, except that the abbreviation "CBMAM" is entered instead of "CB"; for example, CBMAM W MOVG E.

Stratocumulus (SC)

Stratocumulus (SC) clouds form in several ways. They are formed when stratus clouds near the earth's surface lift, cumulus clouds dissipate, or middle cloud layers lower. Stratocumulus are distinguished from cumulus clouds by their flatter appearance. As SC clouds merge into one layer, they appear gray with dark areas. These dark areas are the thicker portions of the SC clouds. Stratocumulus is sometimes mistaken for altocumulus.

The best way to judge whether a cloud is stratocumulus or altocumulus is by the size of the individual elements. The International Cloud Atlas states that when the regularly arranged small elements of the cloud layer have an apparent width of more than 5 degrees, the cloud is identified as SC. An easy method of determining this width is to hold three fingers at arm's length and see if the cloud element is larger than the three extended fingers. If it is not, then perhaps the cloud is altocumulus.

L4 and L5 in foldout 1-1-1 show two examples of typical SC clouds. The rounded masses and rolls of L5 are a unique feature of SC. The variety of SC shown as L4 is frequently formed by the spreading out of cumulus in the late afternoon when the surface heating is greatly diminished.

Precipitation rarely occurs in association with SC clouds. When it does occur, it is usually weak and tends to be intermittent in character. Light snow showers are probably one of the most common forms of precipitation from SC. During cold weather, SC clouds frequently produce ice crystal virga.

C_L-4 and 5 (STRATOCUMULUS).—Low cloud type "4" is encoded only when SC clouds are formed from the spreading out of CU or CB clouds. During this spreading process, CU clouds may still be present. L4 in foldout 1-1-1 shows an example of SC clouds formed from the spreading out of CU clouds. When SC clouds form by other means, they are classified as low cloud "5". C_L-5 essentially includes all SC clouds not formed from the spreading out of CU clouds. If you cannot determine that SC formed from CU, code the cloud as L5.

C_L-8 (CUMULUS and STRATOCUMULUS).—This state of sky is actually a combination of two other low cloud types—CU and SC. When CU and SC clouds have bases at different levels and the SC is formed by means other than the spreading out of cumulus, you classify the cloud type as L8.

Stratus (ST)

Often, a layer of stratocumulus is mistaken for stratus. You can discriminate between ST and a layer of SC by the uniform appearance of the ST cloud base. Stratocumulus always has an unequal distribution of darkness. When dissipating, ST clouds may appear as large, irregular dark patches between lighter colored portions already thinning. The entire cloud takes on a mottled or blotched appearance.

A ST cloud usually forms very close to the earth's surface and is called fog when it is in contact with the earth (50 feet or less). It may also form under other cloud layers such as altostratus and nimbostratus. Stratus is capable of producing only light continuous precipitation, such as drizzle, ice prisms, or snow grains.

Stratus clouds are frequently confused with nimbostratus and altostratus. To help clarify identification, study this comparison:

Stratus:

- Produces only light precipitation, if any
- May reveal the sun through its thinnest parts
- Has a more uniform base than nimbostratus
- Is generally gray.

Nimbostratus:

- Always produces heavier precipitation
- Never reveals the sun
- Has an uneven base
- Is usually darker in appearance than stratus.

When the outline of the sun is distinguishable through stratus clouds, it can be used to distinguish between stratus and altostratus. The sun seen through ST has a sharp, well-defined outline. Altostratus blurs the outline of the sun as if viewed through ground glass. When you are evaluating ST cloud types, you must consider your past observations of the clouds as a basis for proper cloud identification. Stratiform clouds do not just suddenly develop. They usually are associated with a stable condition in the atmosphere and, therefore, evolve slowly.

C_L-6 (STRATUS).—Low cloud "6" is a ST cloud in a more or less continuous sheet or layer, or in ragged shreds, or a combination of both, but it has no stratus fractus of bad weather. The primary difference between L6 and L7 is the presence of bad weather. This term refers to the conditions that exist a short time before, during, and after precipitation. Since all stratiform clouds appear grayish and continuous in form, you must be aware of the identifying features of each stratiform type.

C_L-7 (STRATUS FRACTUS OR CUMULUS FRACTUS).—Low cloud type "7" often occurs below layers of altostratus and nimbostratus, and it is classified as L7 whenever stratus fractus or cumulus fractus of bad weather are present. When these cloud types are present but bad weather conditions do not exist, stratus fractus clouds as L1 (CU). L7 in foldout 1-1-1 shows an example of how the sky appears with these cloud types.

Ragged stratus fractus clouds never occur alone. They are always associated with clouds of low and/or middle types. When they are observed below nimbostratus and similar precipitating clouds, they change shape rapidly and move fast. Stratus fractus and cumulus fractus are usually found beneath the base of CB clouds that are precipitating. However, when this situation occurs, only the CB cloud type is encoded.

EXERCISE (1-1-1)

Name the appropriate low cloud classification for the descriptions and characteristics given below:

1. ________________ **This cloud type is a cloud of moderate or strong vertical development, and does not have a cirriform top.**

2. ________________ **This cloud type is formed by means other than the spreading out of cumulus and has bases at different levels.**

3. ________________ **In its earliest stage of development, this cloud type usually forms in, and indicates good weather.**

4. ________________ **This cloud type has a summit that lacks clear outline, is not clearly fibrous, nor in the shape of an anvil.**

5. ________________ **This cloud type is formed from the spreading out of cumulus or cumulonimbus clouds.**

6. ________________ **This cloud type is formed by means other than the spreading out of cumulus.**

7. ________________ **This cloud type is in a more or less continuous sheet or layer, or in ragged shreds, or a combination of both and bad weather is not present.**

8. ________________ **This cloud type has a cirriform anvil.**

9. ________________ **This cloud type often occurs below layers of altostratus and nimbostratus during bad weather.**

Learning Objective: Given cloud descriptions and characteristics, list the middle cloud subtypes.

Altostratus (AS)

This cloud in the middle height range has features similar to the lower stratus. The primary difference between altostratus and stratus is the composition of the cloud. An AS cloud consists primarily of ice crystals, snow crystals or flakes, and supercooled water droplets. The lower portion of low AS clouds may consist of ordinary water droplets and the upper portion a combination of ice crystals and supercooled water droplets. The composition explains the different features of each cloud.

Altostratus clouds are generally uniform in appearance. They are grayish or bluish in color and appear fibrous. Other basic characteristics are these:

- Altostratus clouds are dense enough to prevent objects on the ground from casting shadows.

● The sun appears as though seen through ground glass when an AS cloud is present. (See M1 in foldout 1-1-2 appearing at the end of this lesson.)

● Halo phenomena never occur with AS clouds.

● Precipitation is continuous.

Precipitation falling from an AS cloud frequently obscures the cloud base. When this occurs, accessory clouds such as cumulus fractus and stratus fractus may form below the AS. Figure 1-1-4 illustrates this condition. During the hours of darkness, AS clouds are even more difficult to identify. At this time, you must watch for such things as a lowering of the ceiling and an increase in the intensity of precipitation. If this happens, you may have nimbostratus. Foldout 1-1-2 shows AS clouds in the semitransparent state (M1) and in the opaque state (M2).

Altostratus clouds, like most other middle clouds, are found at a height range from 6,500 to 23,000 feet in the temperate region. When they are at the higher levels of this middle cloud range, they are often erroneously identified as cirrostratus because of their lighter appearance. However, if there are no shadows cast on the ground, they are AS. Cirrostratus is never dense enough to prevent the sun from casting shadows. When the AS lowers, as during the approach of a warm front, it usually becomes thicker and completely obscures the sun.

C_M-1 (ALTOSTRATUS).—Middle cloud type "1" is an AS cloud, the greater part of which is semitransparent. Usually, the sun or moon is dimly visible as though seen through ground glass. This cloud type is usually found within the higher portion of the middle cloud

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Figure 1-1-4.—Fractus Clouds.

range. This type of AS cloud usually forms from the gradual thickening and lowering of a cirrostratus layer. In a later discussion of the basic cloud form cirrostratus, you will discover they are never thick enough to prevent the sun from casting shadows. Therefore, you can use this rule as a guide in determining whether or not you have AS clouds. M1 in foldout 1-1-2 shows an example of this cloud type. More rarely, this type of AS cloud forms from the extensive spreading out of the middle or upper part of a CB cloud. When altostratus clouds continue to thicken, they are classified as M2 clouds.

C_M-2 (ALTOSTRATUS OR NIMBOSTRATUS).—An AS cloud classified as M2 is a darker gray or a darker, bluish gray than altostratus clouds encoded as M1. The greater part of this AS cloud (M2) is sufficiently dense to hide the sun or moon. A nimbostratus cloud, which is also encoded as M2, is often caused by a further thickening of dense AS.

Nimbostratus (NS)

The word "nimbus" is a Latin word for rain cloud. A NS cloud produces continuous precipitation in the form of rain, snow, or ice pellets.

Nimbostratus is a gray, often dark, cloud that appears diffuse as observed from the ground. This is caused by the continuous precipitation that falls from this cloud. It is always thick enough to completely obscure the sun and is almost exclusively found near frontal zones. It is common to find stratus fractus clouds below NS. These clouds are caused by the falling precipitation from the NS cloud and tend to completely dissipate when the precipitation becomes heavier.

Even though NS is classified as a middle cloud, its base is most often found in the low cloud range. Examples of this are evident as warm fronts approach the station. The AS is soon classified as NS when the cloud increases in density and heavier precipitation occurs. This cloud may continue to lower to within several hundred feet of the surface as the front approaches. Correctly identifying this cloud can alert you to the pattern of weather you can expect at the observation site.

Nimbostratus clouds are distinguished from opaque AS clouds by their denser and darker appearance. The base of an AS cloud has a more diffuse and wet appearance than an AS cloud. However, both of these cloud forms are classified as M2. Nimbostratus clouds usually evolve from the thickening of AS clouds but may also evolve from CB clouds.

Altocumulus (AC)

An AC cloud is composed largely of water droplets, but at very low temperatures it may have some ice crystal development. Altocumulus clouds often look very much like SC clouds. The primary differences between these two cloud types are the size of the elements and their height. One way to distinguish between AC clouds and other cloud forms is to determine the size of the cloud elements. Extending three fingers at arm's length, the size of the elements should fall within the area covered by your fingers. If they do not cover at least one finger, they are probably cirrocumulus. This guide is useful only when the cloud elements in question are more than 30 degrees above the horizon.

When an AC cloud does not have uniformly arranged elements, you must consider other identifying features of the clouds. Altocumulus clouds appear white, gray, or a combination of white and gray. They are in any of the following forms:

- Rounded masses and rolls (such as SC)
- Banded
- Semitransparent
- Lenticular (unusual shaping by the wind)
- Castellated (tufts, turrets, etc.)
- Double layered
- Dark and thick.

Of all the basic cloud forms, AC has more varieties. Altocumulus clouds can evolve from the lifting of lower clouds or, more rarely, from the thickening and lowering of cirrocumulus. As

large CU clouds (TCU or CB) dissipate, the middle portion of the cloud frequently becomes AC. In this case, your selection of the correct type of cloud has a definite meteorological significance to the forecaster. M3 through M9 in foldout 1-1-2 illustrate some typical forms of AC clouds.

The virga phenomenon is common with AC. When it occurs, the precipitation trails appear smaller than those associated with low clouds.

A corona is often present with AC clouds when they are semitransparent. This phenomenon is especially useful to you in determining the type of cloud during hours of darkness. A corona appears as a small ring of light around the moon and appears to blend with the moon's light, whereas a halo presents a large distinct circle of light around the moon. Sometimes, a corona displays the rainbow colors faintly. The corona is caused by the diffraction of light through water particles. The diameter of the corona depends on the size of the water droplets in the cloud. Large water droplets produces a small corona, and small droplets produce a large corona.

C_M-3 (ALTOCUMULUS).—Middle cloud type "3" is an AC cloud, the greater part of which is semitransparent. The various elements of the cloud change slowly and are at the same level. This description of M3 clouds does not imply that some of the elements cannot be opaque. Generally, this cloud type has some degree of opaqueness, but it is predominantly semitransparent. The elements are relatively small and undergo changes very slowly. This cloud type does not progressively invade the sky. Foldout 1-1-2 shows an example of M3 from the horizon to overhead.

C_M-4 (ALTOCUMULUS).—Middle cloud type "4" is an AC cloud in patches, and the greater part of it is semitransparent. The cloud elements occur at one or more levels and continually change in appearance. Often this cloud type (M4) appears shaped as an almond or a fish. These unusual lenticular-shaped cloud forms are mostly found near the mountainous regions but may occur at any location. An additional discussion of this lenticular cloud is presented in the section on orographically-related clouds.

C_M-5 (ALTOCUMULUS).—Middle cloud type "5", AC, is arranged in semitransparent bands or in one or more fairly continuous layers that progressively invade the sky, as shown in M5 in foldout 1-1-2. In either case, the main characteristic of M5 clouds is that they generally thicken as a whole. Once the forward edge of the cloud has reached the part of the horizon opposite to that part where the clouds first appeared, the cloud is no longer classified as M5. This is also the case when the forward edge has ceased advancing.

C_M-6 (ALTOCUMULUS).—Altocumulus clouds classified as M6 must have formed from the spreading out of CU or CB clouds. As large CU clouds or CB clouds dissipate, their remains often consist of large, dark elements. They usually continue to dissipate and thin out to form into separate elements. The best guide to determine the presence of M6 is to view the actual transformation of CU to AC. Foldout 1-1-2 shows two examples of AC clouds formed by the spreading out of CU clouds.

C_M-7 (ALTOCUMULUS OR ALTOCUMULUS WITH ALTOSTRATUS).—Middle cloud type "7" consists of AC clouds in two or more layers. They are usually opaque in places and do not progressively invade the sky. Middle cloud type "7" also consists of AC clouds together with AS or NS clouds. This cloud type is actually a combination of other middle cloud types. For example, if AS (M2) and AC (M3) are present and together, encode the cloud type as "7". Generally, the AC elements of this cloud type are not changing continually. Foldout 1-1-2 shows two examples of AC clouds classified as M7.

C_M-8 (ALTOCUMULUS).—Middle cloud type "8" is an AC cloud with sproutings in form of small towers or battlements. Figure 1-1-5 and foldout 1-1-2, M8 castellanus, illustrate the sproutings. Another form of middle cloud 8 is similar to very small CU clouds or tufts in the middle cloud range, and it often appears ragged. M8 floccus in foldout 1-1-2 shows this situation. When this cloud has the sproutings in the form of turrets, the cloud is called altocumulus castellanus. A remark such as "ACCAS N-NE"

with your observation emphasizes this significant cloud and its direction from the station.

C_M-9 (ALTOCUMULUS).—Middle cloud type "9" is an AC cloud form of a chaotic sky and occurs at several levels. As seen from the ground, this cloud type appears heavy and stagnant. Meteorologically speaking, AC clouds of a chaotic sky are found near low-pressure areas that contain some storm activity. Foldout 1-1-2 shows an example of a chaotic sky. Altocumulus clouds are frequently lifted to higher levels in the atmosphere. When this occurs, they are called cirriform clouds.

EXERCISE (1-1-2)

For the following cloud descriptions and characteristics, list the middle cloud subtypes.

1. ________________ **The greater part of this cloud type is semitransparent and the sun or moon is dimly visible as though seen through ground glass.**
2. ________________ **This cloud type is formed from the spreading out of cumulus or cumulonimbus clouds.**
3. ________________ **This cloud type is sufficiently dense to hide the sun or moon.**
4. ________________ **This cloud type, the greater part of which is semitransparent, does not progressively invade the sky.**
5. ________________ **This cloud type consists of two or more layers, opaque in places, and does not progressively invade the sky.**
6. ________________ **This cloud type is called a chaotic sky and occurs at several levels.**
7. ________________ **This cloud type forms in patches and continually changes in appearance.**
8. ________________ **This cloud type is arranged in bands or in one or more fairly continuous layers that progressively invade the sky.**
9. ________________ **This cloud type forms sproutings in the form of small towers or battlements.**

Learning Objective: Supply the appropriate high cloud classification for given cloud descriptions and characteristics.

Cirrus (CI)

Cirrus clouds generally form between 16,500 and 45,000 feet in the temperate zone. They appear as very white clouds, usually in patches

201.45.1B

Figure 1-1-5.—Altocumulus.

or filaments. The forms of CI cloud that is most readily identified is the hook-shaped CI. This type of CI, figure 1-1-6, is in very fine strands which are shaped into the form of a hook by the wind. H1 through H6 in foldout 1-1-3 (appearing at the end of this lesson) show eight different types of CI cloud formations.

Cirrus clouds of a denser variety, as shown on foldout 1-1-3, H3, frequently evolve from the dissipation of other basic cloud forms such as CB. The cirriform remains of a cloud may spread out to a great extent and completely lose its former identity (anvil shape). Cirrus clouds also form from middle cloud layers that are forced aloft. Cirrus and cirrostratus clouds are often combined in one layer as shown on foldout 1-1-3, H5, and H6. When an extensive cirrostratus layer approaches the station from the distant horizon, the leading edge is usually CI clouds. As the layer continues to approach, the cloud layer becomes more uniform and usually thickens. This situation is quite common in advance of a warm front.

Halo phenomena, figure 1-1-7, can occur with CI clouds, but this is relatively rare. When a halo is present with cirrus, it is usually only a partial halo because of the characteristics of cirrus (strands, filaments, etc.). When the halo is a complete circle, you should suspect the presence of cirrostratus.

C_H-1 (CIRRUS).—High cloud "1" is a CI cloud in the form of filaments, strands, or hooks that do not progressively invade the sky. This cloud type is often present with other CI clouds. In this case, you classify the cloud type as H1 only when the total amount of hooks, filaments, or strands is greater than the combined total of the other CI clouds present. Whatever the situation, remember that H1 does not progressively invade the sky.

69.108.1A

Figure 1-1-6.—Cirrus.

C_H-2 (CIRRUS).—High cloud "2" is a dense cirrus cloud that is in patches or entangled sheaves which usually do not increase in size and which sometimes seem to be the remains of the upper part of a cumulonimbus. An H2 cloud can also be CI with sproutings in the form of small turrets or battlements or CI having the appearance of cumuliform tufts. This dense CI cloud does not originate from CB clouds, although the patches are sometimes rather opaque and have borders of entangled filaments. This can give the erroneous impression that the cloud patches are the remains of cumuliform clouds. When an H2 cloud is present with other CI clouds, the H2 characteristics must predominate the clouds to be encoded as such. H2 and H3 clouds are often mistaken for each other. When it is certain that the cloud evolved from a CB cloud, the cloud is classified as H3.

C_H-3 (CIRRUS).—High cloud type "2" is a dense cloud that is often in the form of an anvil, which is the remains of the upper parts of a CB cloud. The best guide to classify this cloud type is to observe the upper part of a CB cloud as it transforms into dense CI. However, if you have sufficient evidence that the dense CI cloud evolved from cumuliform clouds, you may classify dense CI clouds as H3 even though you do not actually see the transformation. This evidence may come from pilot sightings of CB clouds near your area or the unmistakable features associated with the dissipation of cumuliform clouds (M6 for example).

C_H-4 (CIRRUS).—High cloud type "4" is a CI cloud (in the form of hooks and/or filaments) that progressively invades the sky and becomes more dense. This cloud type is very similar to H1 except that an H4 cloud progressively invades

209.448

Figure 1-1-7.—Halo.

the sky and becomes more dense. These clouds appear to fuse together near the horizon where they first appear, but no cirrostratus clouds are present. When cirrostratus conditions are present, you should examine the clouds closely to determine whether or not to classify the type as H5 or H6.

Cirrostratus (CS)

A CS cloud is a whitish veil very similar in appearance to CI clouds. The primary difference is the great horizontal extent of CS and its more veil-like appearance. Cirrostratus clouds usually produce a halo when the cloud composition is thin enough. Cirrostratus often appears as AS on the distant horizon. In this case, you should consider the speed of movement of the cloud (a CS cloud appears to move more slowly) and the slower changes in form and appearance that are characteristic of CS. Cirrostratus clouds on the horizon are sometimes confused with haze. You can distinguish the haze by its dirty yellow-to-brown color.

A CS cloud is never thick enough to prevent objects on the ground from casting shadows when the sun is higher than 30 degrees above the horizon. Observing the effect that the sun has on CS can be one of your greatest aids in determining the type of CS cloud present. For example, a CS layer may be so thin that only the presence of a halo reveals its presence, as shown in H7 of foldout 1-1-3.

C_H-5 (CIRRUS AND CIRROSTRATRUS OR CIRROSTRATUS ALONE).—High cloud type "5" is CI and CS clouds or CS clouds only. (The CI clouds are often in bands converging towards one point or two opposite points of the horizon.) In either case, they progressively

invade the sky and generally grow more dense, but the continuous veil does not reach 45 degrees above the horizon. Usually, the leading edge of this cloud type is in the form of CI filaments or hooks and, occasionally, resembles the skeleton of a fish. When this cloud type progresses to 45 degrees above the horizon, it is classified as H6.

C_H-6 (CIRRUS AND CIRROSTRATUS OR CIRROSTRATUS ALONE).—High cloud type "6" has the same appearance and features of H5 but extends to more than 45 degrees above the horizon, without the sky being actually covered. Similar to H5, it progressively invades the sky and grows more dense. When the cloud layer covers the entire sky, it is classified as H7.

C_H-7 (CIRROSTRATUS).—High cloud type "7" is a veil of CS clouds covering the celestial dome. This dome is uniform in structure, showing few distinct details. On occasion, the continuous veil of H7 is so thin (transparent) that the only indication of its presence is a halo phenomenon. When lower clouds obscure parts of an overcast CS layer, you may still classify it as H7 if you have evidence that the layer covers the sky. If the CS layer does not cover the sky, classify the cloud type as H8.

C_H-8 (CIRROSTRATUS).—High cloud type "8" is CS which is not or is no longer progressively invading the sky and which does not completely cover the celestial dome. When H8 is present with other cirriform cloud types, it must be predominant to be classified as H8. Though the definition of this cloud type specifically states that the CS clouds are not progressively invading the sky, this refers to the continuous veil form of the CS formation. When CS is in patches (not CI) H5, H6, and H7 are not appropriate classifications. Classify patches of cirrostratus as H8 regardless of whether they are increasing, even though CI and cirrocumulus clouds may also be present but not predominant.

Cirrocumulus (CC)

Cirrocumulus clouds (H9) are very much like the regularly arranged elements of high AC clouds. The basic difference, however, is their size and composition. To be CC clouds, the element must have an apparent width of less than 1 degree. You can measure this by extending your little finger at arm's length. If the element you are evaluating is not larger than your finger, the cloud type is probably CC. Again, this guide is only reliable when the cloud element is higher than 30 degrees above the horizon.

Cirrocumulus clouds consist primarily of ice crystals, but they can also consist of minute super-cooled water droplets that are usually replaced rapidly by ice crystals. Cirrocumulus clouds are observed with a slight corona phenomenon which adds to the beauty of the cloud. When this cloud is present, the sky is often referred to as a mackerel sky because of the cloud layer's resemblance to the scales of a fish. Some observing terms used to identify this cloud are pebbles on a beach, honeycomb, and netlike.

Some forms of CC clouds are similar to altocumulus castellanus clouds. They appear as small tufts or turrets; however, they must be less than 1 degree in width to be classified as CC. H9 in foldout 1-1-3 shows an example of CC development with other cirriform clouds. Some of the elements appear so small that they are difficult to discern with the naked eye.

High cloud type "9" are CC clouds by themselves or accompanied by CI and/or CS clouds, but the CC clouds must be predominant. Be sure that you remember that the elements of CC must have an apparent width of less than 1 degree.

EXERCISE (1-1-3)

Supply the appropriate high cloud classification for the descriptions and characteristics given below.

1. ______________ This cloud type is often referred to as a mackerel sky.

2. ______________ This cloud type is a dense cloud that is often in the shape of an anvil.

3. ______________ This cloud type is uniform in structure, covers the celestial dome, and a halo may be the only indication of its presence.

4. ______________ This cloud type is in the form of filaments, strands, or hooks that do NOT progressively invade the sky.

5. ______________ This cloud type progressively invades the sky and generally grows more dense, but the continuous veil does NOT reach 45 degrees.

6. ______________ This cloud type can have sproutings in the form of small turrets or battlements.

7. ______________ This cloud type is in the form of hooks and/or filaments that progressively invade the sky and become more dense.

8. ______________ This cloud type progressively invades the sky and generally grows more dense. The continuous veil extends to more than 45 degrees.

9. ______________ This cloud type is NOT (or no longer) progressively invading the sky and does NOT completely cover the celestial dome.

OROGRAPHIC CLOUD FORMS

Certain types of clouds are formed as a result of air moving over rough terrain. These clouds indicate the presence of a mountain wave condition in the atmosphere; therefore, they are significant in flight operations. A mountain wave condition consists of turbulent air and strong updrafts and downdrafts. Flight operations in these conditions pose a serious threat to flight safety. As an observer, it is important that you recognize and report these unusual clouds.

The most common orographic clouds belong to the same class as AC, SC, and CU clouds. Listed below are the orographically produced clouds that are related to a mountain wave:

- Lenticular—AC
- Rotor (roll)—CU
- Foehnwall (cap, collar)—SC.

Learning Objective: Given descriptions and characteristics of Orographic Clouds, supply the name and subtype number for each.

Lenticular

The lenticular cloud is an AC cloud (M4) which is almond or fish-shaped. The cloud is observed in patches at one or more levels, and the elements are continually changing in appearance but generally remain stationary in spite of the high wind speeds. They constantly form on their windward side and dissipate on their downwind side. Since the cloud patches are of limited horizontal extent and their elements are continually changing, these clouds are usually semitransparent rather than opaque. The patches, as a whole, may have the form of large lenses and are NOT progressively invading the sky. M4, in foldout 1-1-2, shows an example of standing (stationary) lenticular clouds.

Rotor

Rotor clouds are cumuliform in appearance and are found on the leeward side of the mountain range. Rotor clouds, similar to lenticular clouds, are stationary and are constantly forming on their windward side and dissipating on the leeward side. Because of their vertical development and cumuliform appearance, they are usually encoded as low cloud type "2".

In addition to classifying the lenticular and rotor clouds for cloud code group encoding, you must append remarks (concerning these clouds and their direction from the station) to your weather observation, such as the following:

ACSL OVHD AND W

FEW ACSL FRMG W-NW

APRNT ROTOR CLDS OVR MTNS

The first remark indicates that you observed altocumulus (AC) standing lenticular (SL) overhead (OVHD) and to the west (W) of your station. In the second and third remarks, "FRMG" is the contraction for forming and "APRNT" is the contraction for apparent.

Foehnwall

The foehnwall cloud is SC in appearance and is usually classified as low cloud type "5". This cloud hugs the top of the mountain and sometimes flows down the leeward side of the mountain, producing the appearance of a waterfall.

EXERCISE (1-1-4)

Supply the name and subtype number for each of the following orographic clouds:

1. ____________ This orographic cloud type is observed in patches at one or more levels, and the elements are continually changing in appearance but generally remain stationary in spite of high wind speeds.

2. ____________ This orographic cloud type hugs the top of a mountain and gives the appearance of a waterfall.

3. ____________ This orographic cloud type is found on the leeward side of a mountain range and has vertical development.

CLOUD CODE GROUP

Cloud recognition and identification is only the first part of your job. You must also know how to encode the cloud types so that your observation can be transmitted and used by other weather office personnel to plot on a weather chart. Your cloud code group, correctly encoded, provides anyone who understands the code with a snapshot of the clouds over your station.

Learning Objective: For given cloud types, encode the correct cloud code group.

Encoding $1C_LC_MC_H$ Group (Column 13)

Each 3- and 6-hourly observation must have a cloud code group appended to it. Of course, when the sky is clear or completely hidden by surface obscuring phenomena, a cloud code group is not appended. The $1C_LC_MC_H$ group is entered in column 13 of MF 1-10. (The seqeunce of entry for observations is discussed in a later section of this text.) Presently, the concern is how to encode the cloud types correctly.

Whenever there is only one cloud type present for each cloud division of the atmosphere (C_L, C_M, and C_H), you merely enter the correct type for each division. If no clouds are present in a division, enter a zero for that division. Whenever you have more than one cloud type in a division, you select the type that is the most significant. Table 1-1-1 shows the order of priority for encoding clouds in the $1C_LC_MC_H$ group.

Table 1-1-1.—Order of Priority for Encoding $1C_LC_MC_H$ Group

Order of Priority	Low Cloud C_L	Middle Cloud C_M	High Cloud C_H
1st	9 CB (anvil)	9 AC (chaotic)	9 CC (predominant)
2nd	3 CB	8 AC (turrets)	7 CS (covers sky)
3rd	4 SC (from CU)	7 AC (with AS or NS)	8 CS (not covering or invading)
4th	8 SC & CU	6 AC (from CU)	6 CS (invading, over 45°)
5th	2 CU (large)	5 AC (invading)	5 CS (invading, less than 45°)
6th	1 CU	4 AC (changing)	4 C1 (invading)
7th	5 SC (not from CU)	7 AC (two levels)	3 C1 (from anvil)
8th	6 ST	7 AC (opaque)	2 C1 (dense patches predominant)
9th	7 STFRA, CUFRA	3 AC (semi-transparent)	1 C1 (filaments predominant)
10th		2 NS or AS	
11th		1 AS (semi-transparent)	

Suppose you determine that the following cloud types are present during a state-of-the-sky evaluation:

C_L-2 (towering cumulus)

C_L-5 (stratocumulus at a different level)

C_M-3 (altocumulus)

C_H-1 (cirrus)

C_H-8 (cirrostratus)

How is this cloud observation encoded for the cloud group entry in column 13 of MF 1-10?

Table 1-1-1 shows that L2 takes priority over L5 when low cloud types are encoded. But it is not as simple as this. Generally, you enter the code of the cloud type that has priority; however, when L2 and L5 are both present (at different levels), the low cloud type is classified as L8. This example for encoding low cloud types illustrates the importance of knowing the definitions of the 27 international cloud types. An inexperienced observer might select L2 for encoding. Only one middle cloud (M3) is present in this example; therefore, the cloud group code up to this point is 183. The cirriform cloud types are classified as H1 and H8; therefore, you need to determine from table 1-1-1 which cloud must be encoded. In this case, high cloud 8 takes priority over H1. The correct entry in column 13 of MF 1-10 for this particular state of sky is 1838. You may make the air traffic controllers aware of the presence of the towering cumulus by the remark TCU in column 13 and the direction from the station.

When you cannot determine the middle or high clouds because of lower clouds and/or obscuring phenomena, a slant is entered for $C_M C_H$, or both, as appropriate. If there is less than 10/10 but more than 9/10 sky cover (breaks in an otherwise overcast sky) and no higher clouds are visible, classify this condition as 9/10 sky cover and enter a broken symbol in column 3. When there is less than 10/10 but more than 9/10 sky cover (breaks) and higher clouds are visible, assign a height and sky cover symbol for the higher cloud. For a trace of sky cover (less than 1/10) as the first layer, assign a height and classify as 1/10 sky cover. Enter this condition as a layer in column 3 and a "1" in column 21 if it is the only layer.

EXAMPLES

Column 3	Column 13	Column 21
25 SCT M30 BKN 100 BKN 200 OVC	TCU W/1838	10
M20 BKN	1500	9
15 SCT E200 OVC	1501	10
E80 BKN	1070	8
M15 OVC	15//	10

EXERCISE (1-1-5)

For the following cloud types, encode the correct cloud code group.

1. **C_L-4, C_L-5, C_M-6, C_H-1, C_H-8**
2. **C_M-7 (not overcast)**
3. **C_L-9, C_L-2, C_M-3 (not overcast)**
4. **Overcast (10/10) C_L-5**
5. **Less than 10/10 SC but more than 9/10 (breaks) with no higher clouds visible**
6. **Less than 10/10 SC but more than 9/10 (breaks) with CI visible through breaks.**

SKY CONDITION

Determining the sky condition is largely subjective and requires, above all, practical experience. There is one important reason for a careful evaluation of the sky: almost all changes in surface weather are preceded or accompanied by clouds. For example, frontal passages give advance warning of their presence by a series of changes in clouds and sky conditions. The forecaster interprets the significance of these changes from your observation.

Sky condition is observed and evaluated in layers. During your observation, you consider amount, transparency, and height for each layer. Looking at a series of observations, you can see sky cover transitions by the changes in the observed layer. A change in the amount of a layer from 0.8 to 0.6 may appear unimportant from one observation to the next. However, when this minor change is regarded within a trend and in relation to all the other sky data, an approaching weather situation may be foretold. In observing the sky condition, first you consider the layers of sky cover.

Learning Objective: Given cloud diagrams, determine the cloud layers and heights.

Layers

A layer is defined as "clouds or obscuring phenomena which have bases at the same approximate level." A layer may appear as continuous cover, such as stratus, or it may appear as detached elements, such as fair-weather cumulus. Also, both continuous and detached elements may combine to form a layer. The essential requirement is that their bases be at the same approximate level. The upper portions of a cumulonimbus cloud are often spread horizontally by wind and form a dense cirrus or altiform clouds. These horizontal extensions of the cumulonimbus clouds are regarded as separate layers only if their bases appear horizontal and at a different level from the parent cloud. Otherwise, the entire cloud system should be regarded as a single layer at a height corresponding to that of the base of the cumulonimbus. A layer can be a combination of cloud types or obscuring phenomena at the same level. Obscuring phenomena, such as haze, are often present in the atmosphere but are not considered as a layer unless they have an apparent base. Having divided the state of the sky into layers of clouds, obscuring phenomena, or both, next determine the amount of each layer.

Amount

Though you observe the amount of sky covered by each layer in terms of tenths of sky, contractions are used to describe the sky cover. Table 1-1-2 gives the sky cover contractions and their meanings. These sky cover contractions are entered in column 3 of MF 1-10 for each layer of clouds or obscuring phenomena—surface-based or not. Each contraction represents the portion of the sky that is covered at that layer and below. Figure 1-1-8 illustrates this "at and below" concept of assigning sky cover contractions. The difference between layer and sky cover also is shown.

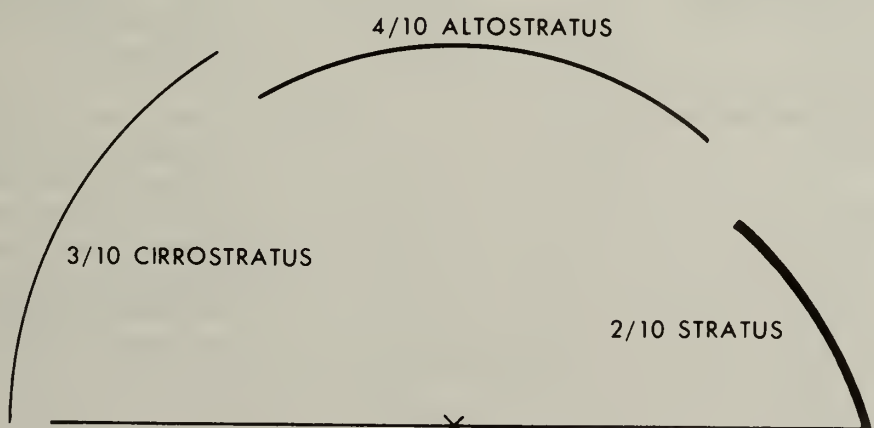


Figure 1-1-8.—Layer and Sky Cover.

Table 1-1-2.—Sky Cover Contractions

<table>
<tr><th colspan="2">Summation Amount of Sky Cover</th><th>Symbol</th><th>Contraction</th><th>Remarks</th></tr>
<tr><td colspan="2">1/10 to less than 10/10 surfaced-based obscuring phenomena.</td><td>–X</td><td>–X</td><td>No height assigned to this condition. Vertical visibility is not completely restricted..</td></tr>
<tr><td colspan="2">10/10 surfaced-based obscuring phenomena.</td><td>X</td><td>X</td><td>Always preceded by a vertical visibility (height) value. Height value preceding this symbol is normally prefixed with the ceiling designator W.</td></tr>
<tr><td colspan="2">Clear</td><td></td><td>CLR</td><td>This symbol (contraction) is not used in combination with any other.</td></tr>
<tr><td>Less than 1/10 thru 5/10, half or more thin.</td><td rowspan="6">ONLY USED TO REPORT LAYERS ALOFT</td><td></td><td>–SCT</td><td rowspan="3">Height values preceding these symbols (contractions) are never designated as ceiling layers.</td></tr>
<tr><td>Less than 1/10 thru 5/10, more than half opaque.</td><td></td><td>SCT</td></tr>
<tr><td>6/10 thru less than 10/10, half or more thin.</td><td></td><td>–BKN</td></tr>
<tr><td>6/10 thru less than 10/10, more than half opaque.</td><td></td><td>BKN</td><td>Height value preceding this symbol (contraction) is prefixed with a ceiling designator (M or E), provided a lower ceiling layer is not present.</td></tr>
<tr><td>10/10, half or more thin.</td><td></td><td>–OVC</td><td>Height value preceding this symbol (contraction) is never designated as a ceiling layer.</td></tr>
<tr><td>10/10, more than half opaque.</td><td></td><td>OVC</td><td>Height value preceding this symbol (contraction) is prefixed with a ceiling designator (M or E), provided a lower broken ceiling layer is not present. This symbol (contraction) is used in combination with lower overcast layers only when such layers are classified as thin.</td></tr>
</table>

In figure 1-1-8, the first layer (2/10 stratus) is entered in column 3 of MF 1-10 as scattered (SCT). This 2/10 amount also represents the total sky cover at this level. The next layer tells a different story. Though the altostratus covers 4/10 sky as a layer, the total sky cover up to this point is 6/10 because of the combined amounts of the first two layers. Thus, the contraction for the altostratus layer is broken (BKN) because of the concept described as "at and below" sky cover. The highest layer (3/10 cirrostratus) is also assigned a broken contraction because the combined total equals 9/10 sky cover.

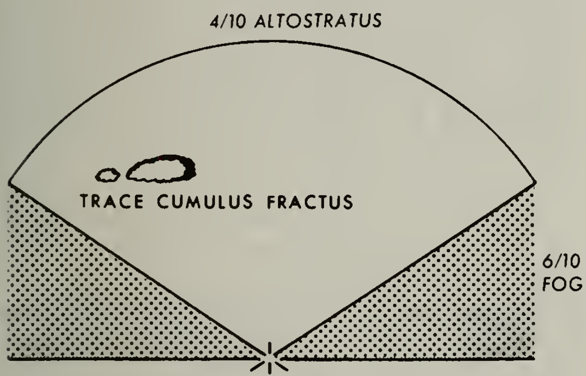


Figure 1-1-9.—Surface-Based Sky Cover.

You can understand how meaningless it would be to enter three separate scattered contractions in column 3 to report these individual layers. To a pilot flying above the highest layer and looking for ground navigational aids, your report of "scattered" sky cover would hide 9/10 of the ground from his view. By reporting a broken sky cover, you have more accurately described the sky condition to the pilot.

Symbols for reporting surface-based obscuring phenomena are also provided. Table 1-1-2 shows that an $-X$ symbol describes a partly obscured condition. Figure 1-1-9 shows another typical sky condition. What sky cover symbols/contractions are entered in column 3 of MF 1-10 for this example? If you selected $-X$ for the first layer, BKN for the next layer (cumulus fractus), and OVC for the highest layer, you are correct. Figure 1-1-9 illustrates two principles. First, the 6/10 fog, even though surface-based, hides the sky just as if it were a cloud aloft. Second, the trace of cumulus fractus must be treated as a layer. Even though this layer covers less than 0.1 sky, it is a layer by definition and also meets the criteria for broken sky cover. This is true because the total at and below that level (including the 6/10 fog) hides enough sky to require the broken contraction.

When sky cover layers are advancing or receding on the horizon, you use the left-hand column of table 1-1-3 as a guide to determine the

Table 1-1-3.—Sky Cover Evaluations

Angle of Advancing or Receding Layer Edge	Tenths of Sky Cover	Angular Elevation of Layer Surrounding Station
0° to 25°	0	0° to 2°
26° to 45°	1	3° to 8°
46° to 59°	2	9° to 14°
60° to 72°	3	15° to 20°
73° to 84°	4	21° to 26°
85° to 95°	5	27° to 33°
96° to 107°	6	34° to 40°
108° to 119°	7	41° to 48°
120° to 134°	8	49° to 58°
135° to 154°	9	59° to 71°
155° to 180°	10	72° to 90°

number of tenths of the sky that is covered by a layer. When a layer of sky cover surrounds the station, use the right-hand column of table 1-1-3 as a guide to determine the number of tenths of sky coverage. Table 1-1-3 takes much of the guesswork out of estimating sky coverage at difficult angles of observation.

During your observation of sky cover, be alert for layers that occur directly beneath another layer. In this case, you cannot add the amounts of both layers to arrive at total sky cover because they hide the same section of the sky; for example, when 0.3 of cumulus is below 0.5 of altocumulus. Together, these two layers hide 0.5 of the sky and, therefore, are both scattered layers. The few samples discussed here help to illustrate the layer versus sky cover principle and entries for sky cover amounts. Another feature that you must consider when observing sky condition is the transparency of the layer.

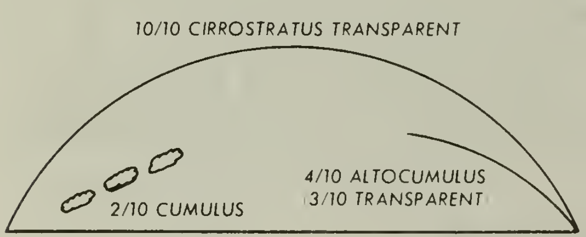


Figure 1-1-10.—Thin Sky Cover.

Transparency

This fancy term means "capable of being seen through." A window is transparent. Opaque is the opposite of transparent. Occasionally, when we talk about certain clouds, such as altocumulus, we use the term semitransparent. That is a proper and accurate description for clouds. For sky cover it is not proper. These semitransparent layers, though they permit the passage of light, do not permit a clear picture of higher layers. Therefore, for practical purposes, consider them opaque when you are deciding between transparency and opaqueness for encoding.

To accurately encode transparent sky cover, you must again recognize the difference between a layer and sky cover. That is, the "at and below" concept importantly affects your decision. Transparent layers are classified as thin. Column 3 entry (MF 1-10) would be −BKN. The minus (−) sign indicates that the layer is thin enough to reveal higher clouds or sky above.

When you observe multiple layers, use the "at and below" concept to obtain "total" opaque and transparency amounts. Figure 1-1-10 shows an example of opaque and transparent layers coexisting in the sky. To solve this problem, start with the lower layer and work up. Let's arrange the amounts for each layer in order and add the transparency totals for each layer. You can count three layers in figure 1-1-10; thus, you need three sky cover contractions. As you add each layer to the total sky cover, the first layer is SCT, second BKN, and

Table 1-1-4.—Sky Cover Height Values

Feet	Reportable Values (Coded in Hundreds of Feet)[1]
5000 or less	To nearest 100 feet
5001 to 10,000	To nearest 500 feet
Above 10,000	To nearest 1,000 feet

[1]Code heights that are halfway between reportable values as the lower of the two heights.

third OVC. Decide now, at which layers the sky cover is thin. Below, you can see the information for each layer arranged in table form:

Layer	Amount	Total Opaque +	Total Transparent =	Total Sky Cover	Sky Cover Contraction
1st	0.2	0.2	-	0.2	SCT
2nd	0.4	0.3	0.3	0.6	-BKN
3rd	1.0	0.3	0.7	1.0	-OVC

It is easy to see that the total transparent sky cover becomes one-half of the total sky cover at the second layer. It, then, is reported as thin broken (-BKN). The sky cover remains thin at the third layer. This is so because the transparent sky cover is well over one-half of the total cover.

It is impossible to report more than one overcast contraction in column 3. The only rule to observe in this case is that only the highest layer may be classified opaque. The lower overcasts must be thin. As a final step in reporting sky cover, you ascribe a height to each reported layer.

Height

Heights of layers must be reported according to established reportable values. Table 1-1-4 shows the reportable values that can be entered in column 3. For example, during the evaluation of sky cover, suppose you detect four opaque layers:

0.2 surface-based fog
0.3 stratocumulus at 4,780 feet
0.0 altocumulus at 9,300 feet
1.0 altostratus at 16,500 feet.

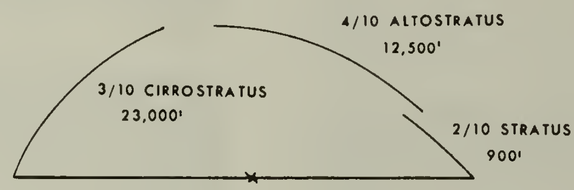
If you use table 1-1-4 correctly, the height entries in column 3 for each layer should be: -X 48 SCT 95 SCT 160 BKN. This example does not indicate a ceiling designator which we discuss separately. Notice that the last layer (altostratus) is exactly halfway between two reportable values. In this case, select the lower height.

In the above example, each height represents the base of the layer above the surface. There is one situation when height represents the vertical visibility into the layer. This applies only to a surface-based layer completely obscuring the sky (X). Since this layer is a ceiling, the discussion of how to obtain its height is discussed later.

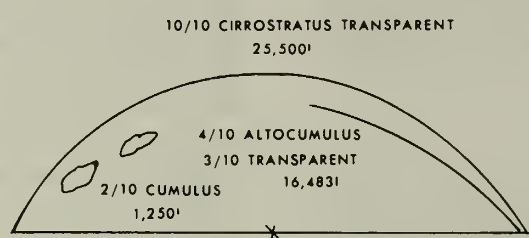
For all sky coverage, whether scattered, broken, or overcast—ceiling or nonceiling—thin or opaque—clouds or obscuring phenomena, you must use the height that is obtained from the most reliable method. Several methods are available for obtaining heights. You must take into consideration not only the reliability of the height data but also the distance from the observation point, the height of the layer, and the time of observation. Do not enter in column 3 (MF 1-10) the method by which you obtained the height measurement, unless you have a broken or overcast layer that is classified as a ceiling. However, the same rules for obtaining heights apply for all layers, regardless of amount. When finally you have the amounts, transparency, and heights of the layers, your last decision involves the sky cover ceiling.

EXERCISE (1-1-6)

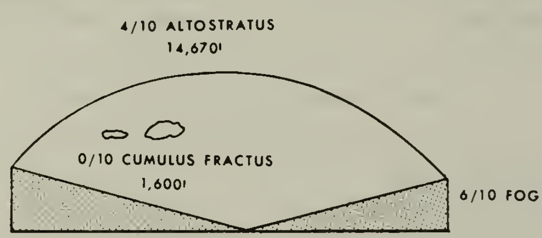
1. **Determine cloud layers and reportable heights from diagram below.**



2. **Determine cloud layers and reportable heights from diagram below.**



3. **Determine cloud layers and reportable heights from diagram below.**



CEILINGS

In many cases, ceiling layers are the controlling factor for aircraft departures, landings, or the diversion of aircraft to another airfield. Low ceilings demand the most accurate measurements possible. Sometimes a difference of 100 feet in the ceiling layer determines whether or not an aircraft can safely land or whether the pilot must seek an alternate field. Therefore,

two important responsibilities in observing sky conditions are that you correctly judge the presence of 0.6 sky cover or more and that you assign an accurate height to the ceiling layer.

In column 3 of MF 1-10, ceiling heights are provided with a ceiling designator. These letter designators (listed below) indicate the method by which you obtain the ceiling height:

Designator	Meaning
M	Measured ceiling
E	Estimated ceiling
W	Indefinite ceiling

Normally, the cloud height set (AN/GMQ-13), commonly called the rotating beam ceilometer (RBC), is used for determining layer or ceiling heights. But the cloud height set has limitations. Let's investigate the methods of obtaining heights to see how and when each one should be used.

Learning Objective: State the methods of obtaining a measured ceiling and the procedures for obtaining cloud heights from the rotating beam ceilometer.

Measured Ceiling Heights

A ceiling is the height ascribed to the lowest opaque broken or overcast layer aloft, or the vertical visibility in a surface-based layer of obscuring phenomena. Ceiling heights are prefixed with an "M" designator whenever they are obtained by a rotating beam ceilometer (AN/GMQ-13), ceiling lights, or known heights of unobscured portions of abrupt, isolated objects (buildings, towers, etc.) within 1 1/2 nautical miles of a runway. Values obtained from either the RBC or ceiling light must be less than 10 times the baseline to be classified as a measured ceiling.

When you use the RBC for obtaining ceiling heights, the following procedures should be followed:

1. During outages of the RBC, if an RBC is available for an alternate runway, it may be used provided, that in your judgment, the measurements are considered to be representative of conditions an aircraft encounters during landing approach.
2. When reactions from the RBC scope for a single broken or overcast layer are present, consider the spot of maximum deflection on the scope as an instantaneous height value. Determine a mean height value by averaging as many angular readings as possible during the period of evaluation.
3. For scattered clouds, use as many scope reactions as are available during the period of evaluation to obtain an average height.
4. When multiple layers are present, supplement scope height indications with visual observations. Average only those reactions which are considered applicable for the layer whose height is being determined.

EXERCISE (1-1-7)

1. **Define a "ceiling."**
2. **What are the three methods for obtaining a measured ceiling?**
3. **What procedures are used when the RBC is out of service?**
4. **What procedure should be used to obtain cloud heights when multiple layers of clouds are present?**
5. **What procedure should be used to obtain cloud heights when scattered clouds are present?**

Learning Objective: Identify and correct false statements concerning estimated (E) and indefinite (W) ceiling heights.

Estimated Ceiling Heights (E)

There are times when you cannot obtain a measured ceiling from your RBC or ceiling light. For example, heights obtained from these measuring sets that are equal to or greater than 10 times their baseline must be classified as estimated (E). The following procedures are used to classify a ceiling as estimated:

AIRCRAFT.—Ceiling heights reported by a pilot (converted from height above mean sea level (MSL) to height above surface) can be classified as estimated when they are:

1. Within 1 1/2 nautical miles of a runway of the airfield and within 15 minutes of the actual time of observation for noncirriform layers. These layer heights need not be used if, in your judgment, they are not representative of conditions over the airfield.
2. Within 50 nautical miles and during the past hour preceding the actual time of observation, for cirriform layers.

BALLOON.—If you cannot determine a ceiling height with a ceiling light, RBC, radar, or pilot report, it should be determined by balloons whenever necessary. For example, if the ceiling is at or below the minimum height for VFR operations or the ceiling height is 2,000 feet or less and the presence of a stratus-type cloud layer makes estimation difficult, a balloon may be used to estimate the ceiling.

A balloon ceiling is based on the known ascension rate of a pilot or ceiling balloon. Ascension rates are fixed by the amount of lift given to the balloons. Proper balloon inflation (neither over- nor under-inflated) controls the lift. When using a balloon to determine ceiling heights, use the following procedures:

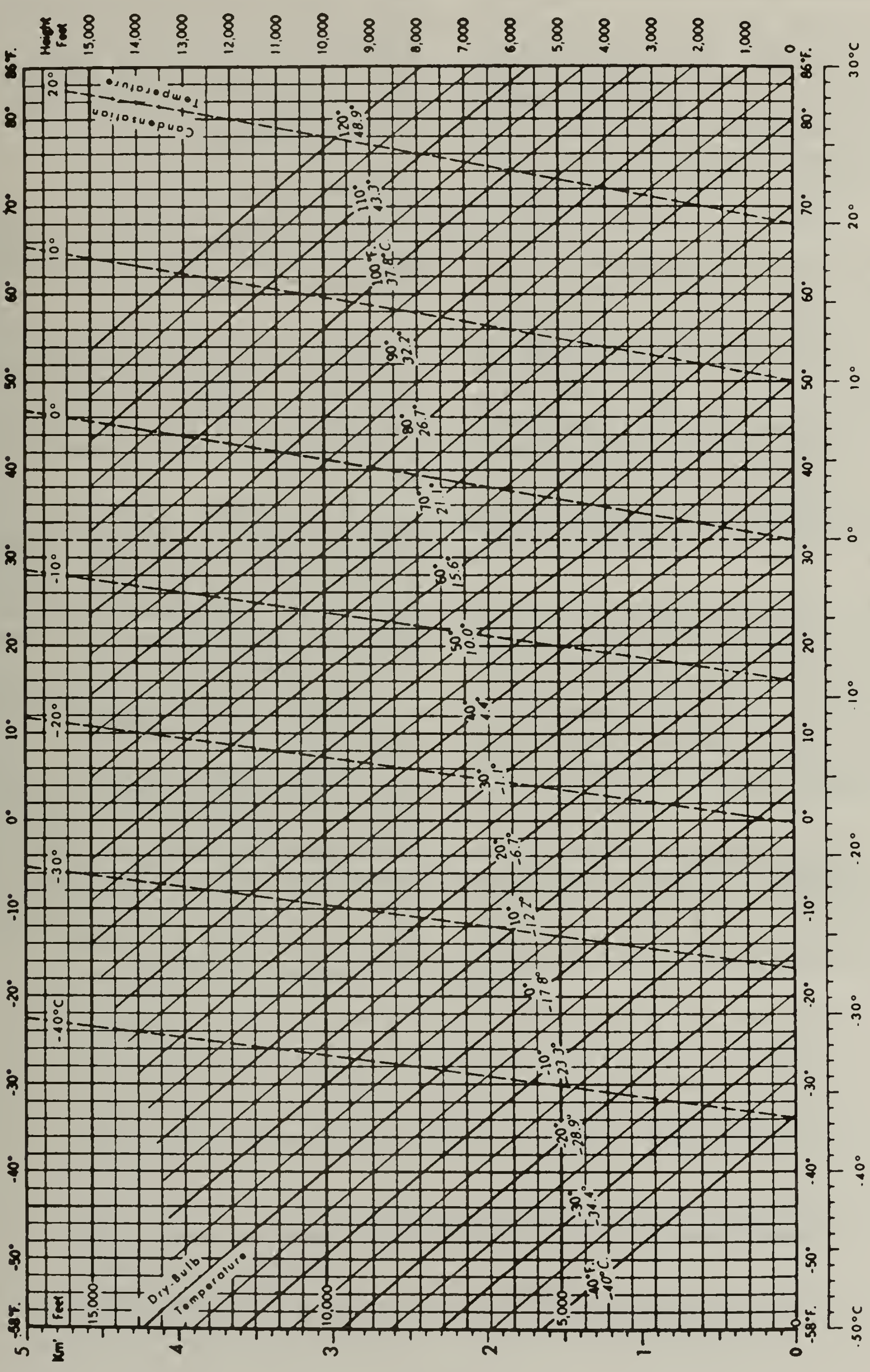
1. Choose a balloon of the appropriate color—red for thin clouds and blue or black balloons under all other conditions.
2. Watch the balloons continuously, determining with a stop watch (or any watch having a second hand) the length of time that elapses between the release of the balloon and its entry into the base of the cloud layer. The point of entry is midway between the time the balloon first begins to fade and the time of complete disappearance.
3. Then determine the height above the surface from prepared tables in the FMH-1B.

The accuracy of the height obtained by a balloon is decreased when the balloon does not enter a representative portion of the cloud base, is used at night with a light attached, or is used during the occurrence of hail, ice pellets, any intensity of freezing rain, or moderate-to-heavy rain or snow.

CONVECTIVE CLOUD HEIGHT DIAGRAM.—This method is not suitable for stations in mountainous or hilly terrain. It should be used only when the clouds present are formed by active surface convection in the vicinity of your station. The diagram (figure 1-1-11) is usually most accurate when estimating the height of cloud bases at 5,000 feet or less. Recent dewpoint and free air temperature readings must be available.

To use the diagram in figure 1-1-11, locate the dewpoint temperature at the base of the diagram (vertical solid lines) and the dry-bulb temperature (sloping solid lines), and follow these lines to the point where they intersect. Follow this intersection point horizontally to the right side of the diagram, and read the estimated cloud height. This value represents the base of the convective clouds at your station. For example, assume that you have a dewpoint temperature of 58 °F and a free air temperature of 75 °F. The estimated cloud height is 4,000 feet. One important fact to remember when you use this method is that as changes in the dewpoint and temperature occur, you should recompute the height.

NATURAL LANDMARKS OR OBJECTS.—Known heights of unobscured portions of natural landmarks or objects more than 1 1/2 nautical miles from any runway of an airfield can be used to estimate a ceiling height.



209.449

Figure 1-1-11.—Convective Cloud Height Diagram.

Most weather offices have visibility charts that provide you with the heights of any hills, mountains, TV towers, etc., that are within the area of your base. If, for example, there is a hill three miles from your base with a known height of 600 feet and the cloud base that you are trying to evaluate is touching the top of the hill, you can estimate the height of the ceiling as 600 feet.

OBSERVATIONAL EXPERIENCE.—You can estimate a cloud height by observational experience provided the sky is not completely hidden by surface-based obscuring phenomena and other guides are lacking or, in your judgment, are unreliable. You can also consider the persistence of heights previously classified as measured. Your estimations should be checked, whenever possible, against a reliable method of measurement. This comparison tells you whether you usually estimate high or low under different sky cover conditions.

RBC OR CEILING LIGHT.—You can estimate ceiling heights from an RBC or ceiling light when their values equal or exceed 10 times the baseline used. For example, if the baseline of the RBC is 400 feet, an angular reading of 84 degrees would equal 3,800 feet. Therefore, any angular reading over 84 degrees can only be used as an estimated height.

WEATHER-SURVEILLANCE RADAR CEILING HEIGHTS.—The range height indicator (RHI) scope of the AN/FPS-106 can be used to estimate cloud heights. However, such height indications seldom compare well with indications from cloud height measuring equipment for heights below 10,000 to 12,000 feet. RHI scope displays are also not reliable for detecting the heights of cirriform clouds. Ordinarily, RHI scope indications only aid in evaluating the heights of middle clouds.

Indefinite Ceiling Heights (W)

Ceiling values are classified as "indefinite" when the vertical visibility in a surface-based obscuring phenomena is:

1. The distance that you can see, from the ground, vertically into an obscuring phenomena which completely conceals the sky.
2. Based on the visible portions of nearby objects (buildings, control towers, etc.) on the airfield complex.
3. Based on height equivalent to a ceilometer upper limit reaction. Consider the point at which deflection on the scope of the RBC becomes zero deflection as an evaluation of the vertical visibility. Use the average value obtained from at least four consecutive sweeps as a representative (W) ceiling height.
4. Based on the top of a ceiling light beam, or the height at which a balloon completely disappears.
5. Based on the maximum vertical height from which a pilot can see the ground. The report must occur with 1 1/2 nautical miles of the runway and with 15 minutes of the actual time of an observation. Pilot reported values need not be used if, in your judgment, they are not representative of conditions over the airfield.

EXERCISE (1-1-8)

From the list of statements below, concerning estimated and indefinite ceiling heights, identify and correct those that are false.

1. A ceiling height reported by a pilot is coded as estimated in column 3, MF 1-10, in height above MSL.
2. An aircraft ceiling can be classified as estimated if the report is within 1 1/2 nautical miles of the airfield and within 15 minutes of the actual time of observation for noncirriform layers.
3. The approximate color of balloon to use for estimating a thin cloud layer is black.
4. The convective cloud height diagram is suitable for use in mountainous or hilly terrain.
5. When using the convective cloud height diagram, you should recompute the cloud layer heights as changes in the dewpoint and temperature occur.
6. When an indefinite (W) ceiling height is based on the upper limit of a ceilometer reaction, you use at least six consecutive sweeps as a representative ceiling height.
7. Known heights of unobscured portions of natural landmarks or objects more than 1 1/2 nautical miles from any runway or an airfield can be used to estimate ceiling height.
8. Estimated ceiling heights from an RBC or ceiling light can be used only when their values are less than 10 times the baseline used.
9. Height indications from the RHI scope of the FPS-106 can be used for estimating heights of cloud layers below 10,000 feet.
10. An indefinite (W) ceiling is the distance you can see, from the ground, horizontally into an obscuring phenomena that completely hides the sky.
11. RHI scope indications, from the FPS-106 radar, are most useful to you in evaluating the heights of middle clouds.
12. The accuracy of an estimated balloon ceiling height is decreased when the balloon does not enter a representative portion of the cloud base.
13. Pilot reports of ceiling heights within 1 1/2 nautical miles of a runway and 15 minutes of observation time for noncirriform layers need not be used if, in you judgment, they are not representative of conditions over the airfield.
14. If you cannot determine a ceiling height with an RBC, ceiling light, or pilot report, the ceiling should be determined by balloons whenever locally deemed necessary.
15. An indefinite (W) ceiling height can be based on the visible portions of objects (buildings, control towers, etc.) on the airfield complex.

CEILING/SKY REMARKS AND ENTRIES

Some facts that the standard column 3 entries MF 1-10, do not reveal are ceilings that vary in height or amount, significant clouds, or other significant features about the sky cover. This significant information is added, when necessary, to the airways observation.

Learning Objective: Given simulated sky condition illustrations and descriptions, classify the sky cover amounts into layers, assign reportable heights, select the ceiling layer, record special remarks, and encode a cloud code group.

Variable Ceiling

Rapid fluctuations of a ceiling indicate an irregular base; therefore, the height is variable. A variable ceiling is reported whenever the ceiling height is less than 3,000 feet and rapidly decreases and increases by one or more reportable values during the time of observation. The height of the ceiling is the average of all the observed values. A variable ceiling is not based on rapid fluctuations of the instrument readings alone. Visual observation is needed to exclude the possibility that the fluctuation is caused by separate layers.

To enter a variable ceiling, average the readings obtained during the ceiling observation. Enter the average (use reportable values only) as the ceiling height in column 3. This average value is suffixed with the letter "V" to indicate that the ceiling is variable; for example, M15V BKN. Whenever you make a variable ceiling entry in column 3, you must enter a remark for the lowest and highest value of the ceiling in column 13, such as CIG 11V19. When considered together, the entries M15V BKN and CIG 11V19 make a complete description of the ceiling layer.

Variable Sky Condition

Variable sky condition describes a sky condition which has varied between reportable conditions (e.g., SCT to BKN, BKN to OVC, etc.) during the period of observation (normally the past 15 minutes). This condition is reported in column 13 when the layer is below 3,000 feet. Nothing need be remarked when a layer varies in amount from 4/10 to 5/10 because both amounts qualify as a scattered layer. Enter a remark for those amounts that vary between reportable values—5/10 to 6/10 (scattered to broken), or when the variability goes from 6/10 to 5/10 (broken to scattered).

Enter in column 13, at the time of observation, a "V" and the condition to which it varies during the period of observation. When necessary to distinguish between column 3 entries, include the layer's height; i.e., SCT V BKN, BKN V SCT, 18 OVC V BKN.

Breaks (BRKS)

Report breaks or an area absent of clouds in a layer, below 1,000 feet, which covers 6/10 but less than 10/10 of the sky. Enter BRKS in column 13, followed by direction from station. Omit the remark if the breaks are in all quadrants; i.e., BRKS S, BRKS OVR APCH LTS.

The remarks BRKS for a broken layer below 1,000 feet is very important to flight operations. This remark discloses to the pilot the location of the clear area in the broken layer. When you know the direction from your observation point to the approach end of the duty runway, you should report BRKS OVR APCH LTS when the remark is appropriate. Approach lights are significant because they are located off the end of the runway where the pilot makes his landing approach; therefore, if this portion of the sky is free of clouds, you should append this remark to your observation. Check with the tower personnel to find out the duty runway prior to making your observation.

Other Remarks

Other remarks describe a variety of observed features. Perhaps you might observe that the ceiling or sky condition at a distance from your

station appears to be different. If you can find evidence that this is so, remark it in a fashion that tells exactly what you see. Here are samples of remarks you might use:

- CIG LWR OVR CITY—ceiling lower over city
- CLD BASES OBSCG MTNS W—cloud bases obscuring mountains to the west
- LWR CLDS W APCHG STN—lower clouds west approaching station.

OBSCURING PHENOMENA ALOFT.—When obscuring phenomena are aloft rather than surface-based, you must report the height and sky cover symbol with the type. For example, enter a scattered layer of smoke at 1,000 feet as K10 SCT (sky cover contraction from column 3). To enter this remark in column 13, you need to have a corresponding height and sky cover contraction in column 3.

SURFACE-BASED OBSCURING PHENOMENA.—Whenever you report a sky condition that includes a partly obscured condition (−X), indicate in column 13 the phenomena producing the obscuration. Indicate the tenths of sky obscured following the obscuration symbol, e.g., "F6," "S8," "FK3," etc. No entry is required when the amount of obscuration is zero or ten tenths. Enter direction of breaks or discontinuity in an obscured sky (X); e.g., "THN F NW, BRK IN FOG TO SE," etc.

SIGNIFICANT CLOUDS.—The use of cloud remarks with an observation usually produces a variety of opinions. The following cloud remarks are usually considered significant at any location. Therefore, you should be able to report them properly:

Cloud Type	Sample Remarks
Towering cumulus	TCU, distance (if known), and direction from station; i.e., TCU NE, TCU 25 SW
Cumulonimbus (no thunderstorm is being reported)	CB, distance from station (if known, based on radar or pilot report), direction from station, and movement (if known), i.e., CB 20S MOVG NE, CB OVHD MOVG E
Cumulonimbus mamma (with or without thunder)	Same as cumulonimbus, except use CBMAM: i.e., CBMAM 10W MOVG SE
Altocumulus castellanus	ACCAS and direction from station; i.e., ACCAS SE
Standing lenticular or rotor clouds	Description and direction from station; i.e., ACSL SW-W, APRNT ROTOR CLDS S, CCSL OVR MTNS S
Vertical or inclined trails of precipitation attached to clouds but not reaching the surface	VIRGA and direction from station; i.e., VIRGA NW.

EXERCISE (1-1-9)

For each of the following diagrams and corresponding descriptions, classify sky cover amounts into layers, assign reportable heights, select the ceiling layer, record special remarks, and encode the appropriate cloud code group.

1. 3/10 CU of little vertical development. It took a 30-gram balloon one minute and 10 seconds (820′) to enter the layer. 4/10 SC, not from cumulus, with a variable reading on the RBC going from 1,200′ to 1,300′ to 1,200′ to 1,400′:

   a. Ceiling and sky cover:______________

   b. Remarks:______________________

   c. Cloud code group:_______________

2. 4/10 stratus fractus (3/10 transparent) is present at an estimated height of 300′.

   10/10 NS at a height of 650′ as determined by the RBC 10 minutes ago.

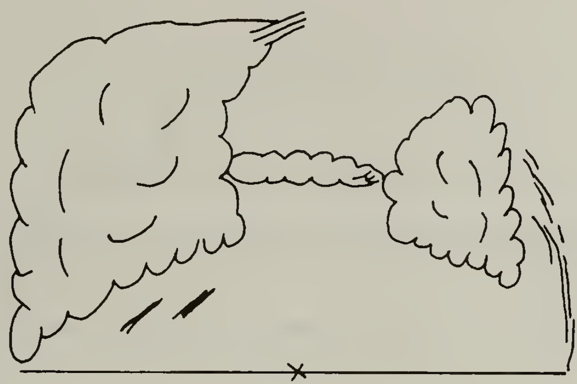
   Some precipitation is occurring to the west of the station, but it is not reaching the ground:

   a. Ceiling and sky cover:______________

   b. Remarks:______________________

   c. Cloud code group:_______________

EXERCISE (1-1-9)—Continued



3. 2/10 stratus fractus, of bad weather, at a measured height of 150′.

   4/10 CBMAM, moving towards the southeast at an estimated height of 1,750′.

   2/10 CU, of great vertical extent, at an aircraft height of 2,400′ above the surface.

   2/10 AC from cumulus, at an estimated height of 19,000′.

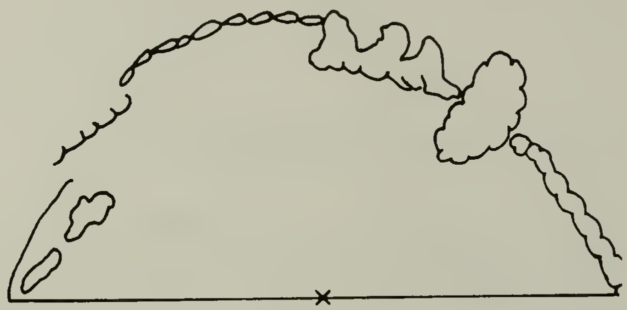
   2/10 CI, the remains of the upper part of a CB, at a height of 42,500′ as determined by a radar RHI scope:

   a. Ceiling and sky cover:______________

   b. Remarks:________________________

   c. Cloud code group:______________

EXERCISE (1-1-9)—Continued



4. 1/10 cumulus fractus 500′.

1/10 TCU, east at 1,400′.

2/10 AC, from cumulus, at an estimated 6,500′.

2/10 AS, semitransparent and having a base at an estimated height of 9,500′.

2/10 ACCAS at an estimated height of 13,000′.

1/10 CI, in hooks and strands, not progressively invading the sky, reported by aircraft to be 21,000′ above the surface.

2/10 CC at an estimated height of 22,000′.:

a. Ceiling and sky cover:______________

b. Remarks:_________________________

c. Cloud code group:_________________

EXERCISE (1-1-9)—Continued

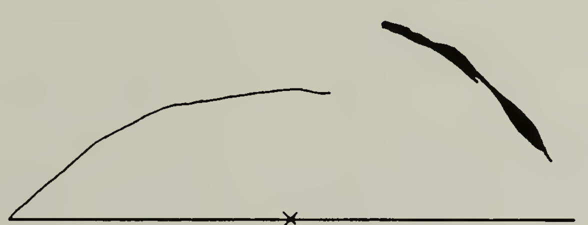
5. 3/10 CB, with anvil-shaped top, at a height of 1,750′.

   2/10 AC in the shape of an almond and having no apparent motion at a height of 17,500′:

   a. Ceiling and sky cover:______________

   b. Remarks:__________________________

   c. Cloud code group:_________________



6. 6/10 ST at 240′ determined by the known height of a radio tower 1/2 mile to the south. The layer has varied from 6/10 to 5/10 during the period of observation.

   3/10 AS, semitrasnsparent, at an estimated height of 7,000′:

   a. Ceiling and sky cover:______________

   b. Remarks:__________________________

   c. Cloud code group:_________________

EXERCISE (1-1-9)—Continued

7. 5/10 smoke (3/10 transparent) at 1,000′ from the RBC.

   1/10 CU, of little vertical development as determined from the convective cloud height diagram (refer to figure 1-1-11). Dewpoint = 52°, temperature = 65°:

   a. Ceiling and sky cover:______________

   b. Remarks:__________________________

   c. Cloud code group:_________________

8. 6/10 ST at an estimated height of 700′. There are some small breaks in the layer northeast of the station.

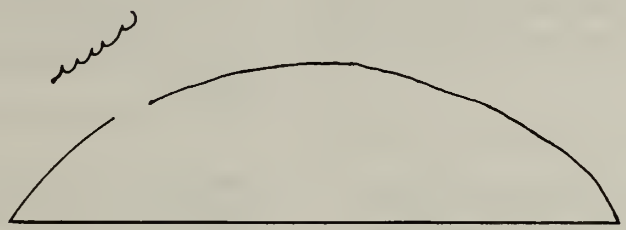
   3/10 AS, all transparent, at an estimated height of 7,000′:

   a. Ceiling and sky cover:______________

   b. Remarks:__________________________

   c. Cloud code group:_________________

EXERCISE (1-1-9)—Continued



9. **10/10 ST determined by a 30-gram ceiling balloon at a height of 1,000′. There is a small break in the layer to the northwest through which some clouds are visible at an estimated height of 3,500′:**

   a. **Ceiling and sky cover:**______________

   b. **Remarks:**__________________________

   c. **Cloud code group:**_________________

10. **6/10 AC, semitransparent and not changing at an estimated height of 13,000′.**

    10/10 CS can be seen through the areas between the AC elements. The base of the CS is estimated at a height of 46,000′. There are small breaks overhead:

    a. **Ceiling and sky cover:**______________

    b. **Remarks:**__________________________

    c. **Cloud code group:**_________________

CLOUD HEIGHT MEASURING EQUIPMENT

Observation of all weather elements, in some way, involves a measuring device. The primary cloud height measuring set used by AGs is the AN/GMQ-13.

Learning Objective: State the normal baseline, the requirements for operation, the turn-on procedures, the calibration procedures, and the limitations of the rotating beam ceilometer.

Cloud Height Set (AN/GMQ-13)

The AN/GMQ-13 is often called the rotating beam ceilometer (RBC) because the projected light beam rotates through its measuring arc. The RBC offers several advantages. First, a rapid measuring sweep (every other sweep is a measuring sweep) provides a measurement approximately every six seconds. Second, it provides measurements of clouds during all periods of operation, day or night. Third, a dual light system allows height measurements even though one light burns out. Fourth, the baseline length allows height measurements between a range of 50 to 4,000 feet with a reasonable degree of accuracy.

The length of the baseline determines the maximum height that clouds can be considered measured with accuracy for observational purposes. Shortening the baseline to less than 400 feet decreases the maximum height of accurate measurements. Increasing the baseline increases the maximum height, but other limiting factors may arise. They include light beam cutoff by low-hanging fragments, attenuation of the light beam intensity by fog or other obstructions to vision, and diffusion of the light beam by water droplets.

PERIOD OF OPERATION.—The presence of low clouds or fog governs the period of RBC operation. The RBC should be turned on whenever one of the following conditions exists at your station:

1. When clouds are present within the height measuring capability of the set or fog is present.
2. When either of the above conditions is forecast or expected to be present within three hours.
3. When a local need exists.

When none of these conditions exists or is not expected to occur within three hours, you may keep the RBC in standby. To obtain height readings from the RBC, you must be able to adjust the sweep, read the scales, and interpret the scope.

ADJUSTING THE SWEEP.—Figure 1-1-12 shows the controls used to adjust the sweep. After you turn on the POWER and Z MODULATION toggle switches, begin the sweep adjustment by turning the BRIGHTNESS control clockwise until the sweep appears on the scope. Use the HORIZ CENTER control to make the sweep run along the vertical centerline of the scale, and adjust the FOCUS to obtain the sharpest beam. Place the CALIBRATE switch in each position and adjust as follows:

- Position number 5. Sweep should appear at 0 degrees. Adjust with the SWEEP LENGTH control.

- Position number 4. Sweep should appear at 90 degrees. Adjust with the SWEEP LENGTH control.

- Position number 3. Sweep should appear at 45 degrees. Adjust with the VERT CENTER control.

- Position number 2. Sweep flashes in each of the rectangles on the scale (18 degrees markers). If not, readjust the other calibration settings. After these adjustments, place the CALIBRATE switch in position number 1. The sweep should trace the proper length (0 to 90 degrees). Adjust the HORIZ GAIN control until about 1/8 inch of noise (sweep width) is present. During sweep adjustment, the PROJECTOR switch has been OFF. When you turn it on you may find the projector and indicator are not synchronized.

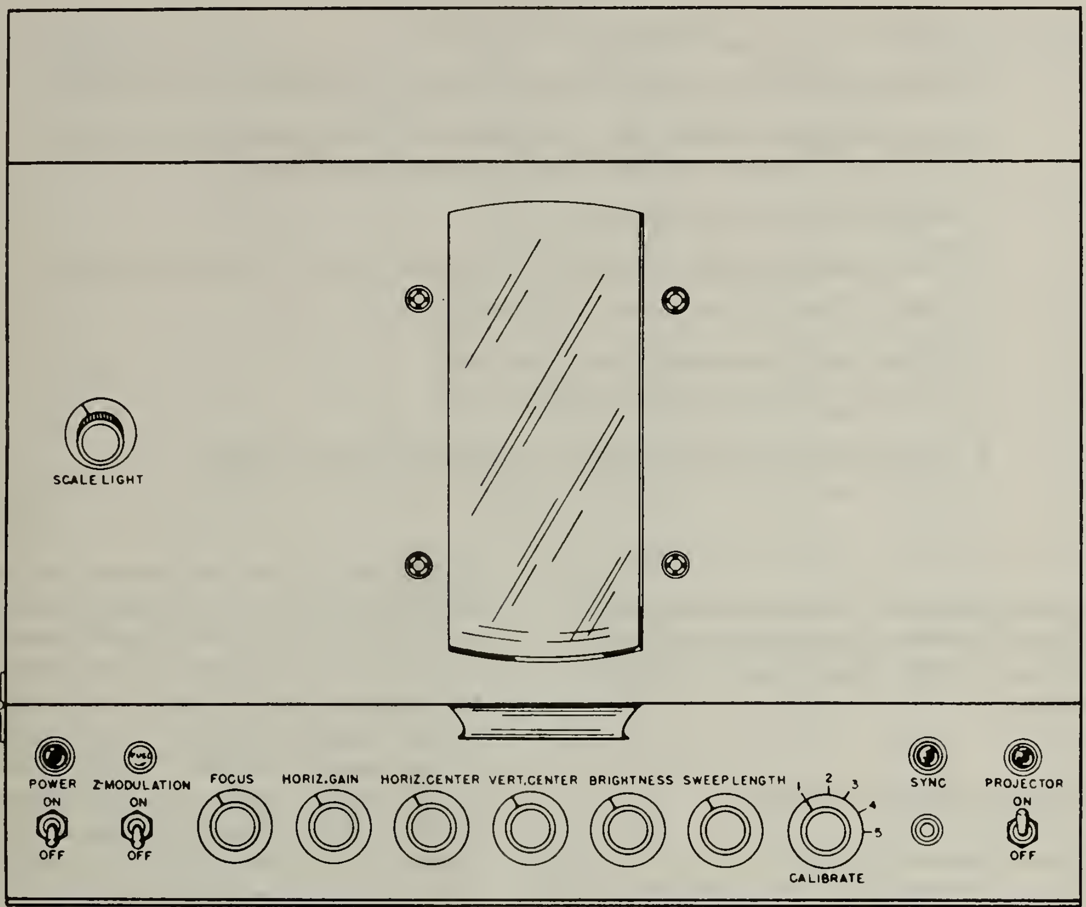


Figure 1-1-12.—GMQ-13 Indicator Controls.

The indicator uses a pulse that shows when the indicator sweep is synchronized with the projector. The "SYNC" pulse appears as a short step that is displaced to the right of the sweep of the sweep path. The SYNC pulse should appear at the bottom 2° degrees of the sweep. This step is commonly called the ZERO STEP, and occurs every fourth sweep. If the SYNC pulse appears anywhere else, push the SYNC button momemtarily. The indicator sweep will come to rest at 0 degree until it becomes synchronized with the projector. During the 0 degree rest time, the SYNC lamp is lit. When synchronization is achieved, the indicator sweep automatically begins its cycle and the SYNC lamp goes out.

EXERCISE (1-1-10)

1. **What is the normal baseline for the RBC?**
2. **What are the three conditions which require the RBC to be turned on?**
3. **The calibration switch has five positions. What occurs at each of the positions? How do you make the necessary adjustments?**
4. **State the turn-on procedures.**
5. **What position should the calibration switch be in for normal operation?**
6. **What is the purpose of the SYNC button?**
7. **What is the main limitation of the RBC?**
8. **How often does the ZERO STEP occur?**
9. **How often can a measurement be obtained from the RBC?**

Learning Objective: From simulated RBC scope indications, determine the height of the base(s) of the cloud(s) and/or vertical visibility.

Scale Overlay (400 Feet Baseline)

To accurately read the indicator scale on the cathode-ray tube (CRT), you must keep one caution in mind. The measured height changes rapidly as the elevation angle approaches 90 degrees. In other words, a large change in measured height. With a baseline of 400 feet, height indications registered on the scale, above 76 degrees elevation angle, must be carefully observed to avoid misreading the scale by one or more reportable values (see table 1-1-5).

Scope Interpretation

Interpretation of the patterns on the overlay of the scope requires experience more than anything else. As an aid, a few typical patterns are illustrated in figure 1-1-13. These illustrations present only generalized pictures and do not portray the many variations that can occur. A brief discussion of details A through F of figure 1-1-13 follows:

1. Details A, B, and F are single-cloud indications. As the projector beam shines on the cloud directly over the detector, the scope trace widens. The base of the cloud is at the base of the widest part of the scope trace. Detail A shows an abrupt deflection that places the base at 60 degrees and 700 feet. The trace in detail B widens less abruptly with the widest point at 62 degrees and 750 feet. These two details show clouds whose bases are well defined, such as cumulus clouds. Detail F shows a diffuse or less defined cloud base, such as the base of a status cloud. The scope depicts the base at 75 degrees and 1,500 feet.

2. Detail C apparently presents two cloud layers at 46 and 65 degrees. When multiple layers appear on the scope, you should verify their existence by an outside visual observation, if possible. Do this to avoid reporting a noise signal as a cloud layer.

3. Detail D depicts a low ceiling accompanied by fog at the surface. The fog causes the wide trace at the surface. The base of the cloud is indicated at the widest part of the bulge or about 100 feet.

4. Detail E shows two features. Reflection of the light by falling snow causes a wide trace at the surface. However, enough of the projected light reaches through the snow to strike the cloud base at 60 degrees. Frequently, precipitation or dense surface fog reduces the amount of projected light received at the photocell so that

Table 1-1-5.—Height Values for the RBC with a 400-foot Baseline

ANGLE	REPORT VALUE	ACTUAL VALUE	ANGLE	REPORT VALUE	ACTUAL VALUE	ANGLE	REPORT VALUE	ACTUAL VALUE
5		35	33		260	62		752
6	0	42	34		270	63	800	785
7		49	35		280	64		820
8		56	36	300	291	65		858
9		63	37		301	66	900	898
10		71	38		313	67		942
11		78	39		324	68		990
12		85	40		336	69	1000	1042
13	100	92	41		348	70	1100	1099
14		100	42		360	71		1162
15		107	43		373	72	1200	1231
16		115	44		386	73	1300	1308
17		122	45	400	400	74	1400	1395
18		130	46		414	75	1500	1493
19		138	47		429	76	1600	1604
20		146	48		444	77	1700	1733
21		154	49		460	78	1900	1882
22		162	50		477	79	2100	2058
23		170	51	500	494	80	2300	2269
24		178	52		512	81	2500	2526
25		187	53		531	82	2800	2846
26	200	195	54		551	83	3300	3258
27		204	55	600	571	84	3800	3806
28		213	56		593	85	4600	4572
29		222	57		616	86	5500	5720
30		231	58		640			
31		240	59		666			
32		250	60	700	693			
			61		722			

only the tapered portion of the trace appears, such as shown in detail E from the surface to 400 feet. A tapered trace should help in estimating the vertical visibility into the phenomenon.

5. Another feature in details A, B, and C needs to be mentioned. Notice the bulging trace in detail A at about 20 degrees, again, in detail B at 10 and 20 degrees, and also in detail C at 15 degrees. These depict noise signals that are generated either within the set or from external radio or light sources. Noise signals are often characterized by their random patterns; that is, they do not appear as a fixed signal from scan to scan. Also, a signal appearing between measuring scans, when no signal information is being presented, gives a further indication that you are receiving noise. High-intensity flasher interference does cause regularly spaced signal reactions about 15 degrees apart on the indicator scope. Noise signals also show narrow, sharp deflections as well as the gradual bulges shown in the illustrations. Although you cannot eliminate noise signals, you can reduce their effect upon the scope trace by turning the HORIZ GAIN control to a lower setting.

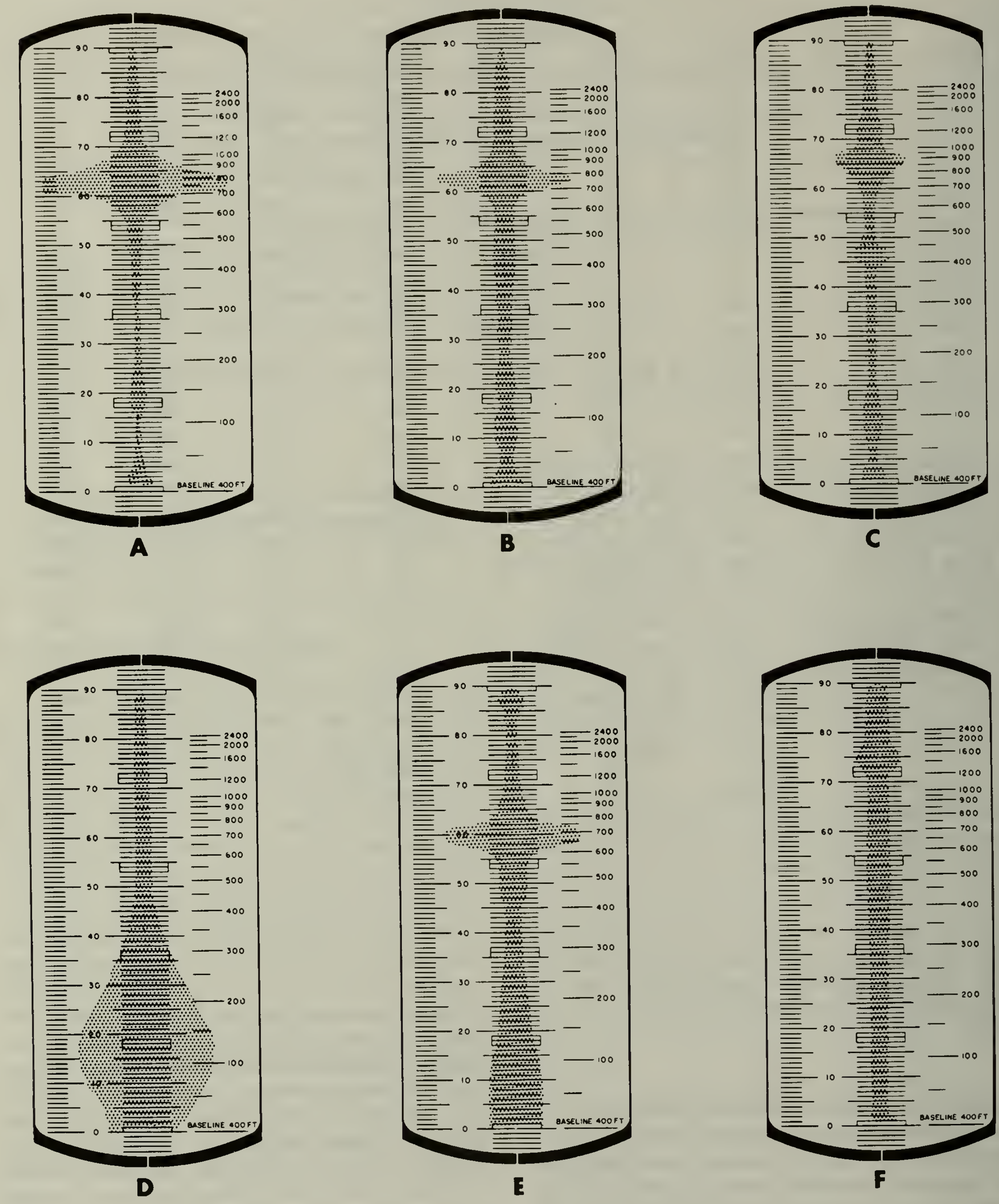
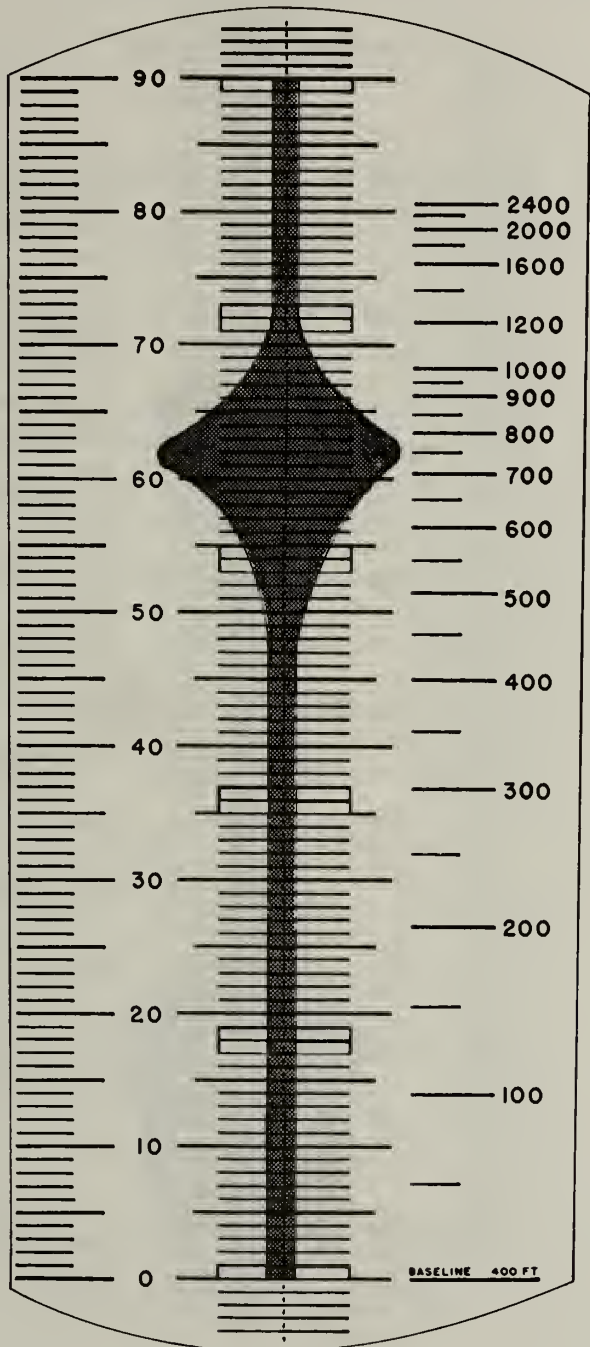


Figure 1-1-13.—RBC Scope Interpretations.

EXERCISE (1-1-11)

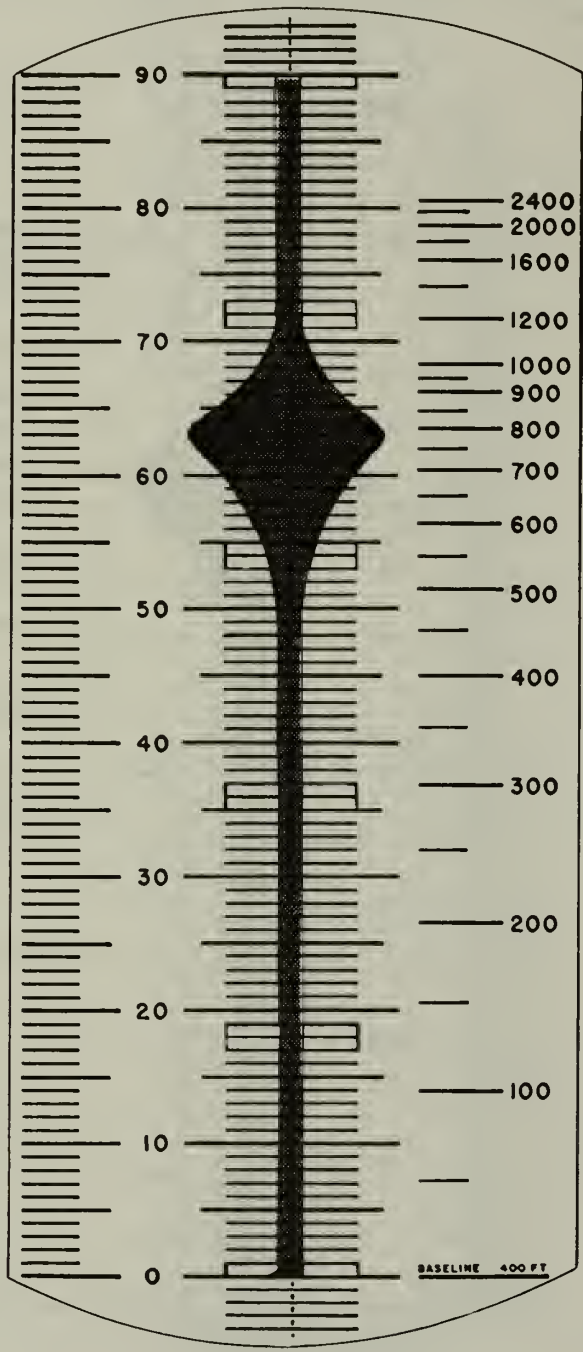
For each of the following figures, determine the angle and height of the base of the cloud(s) and/or vertical visibility. Use table 1-1-5 to determine the reportable value.



1. a. Angle____________________

b. Reportable height____________________

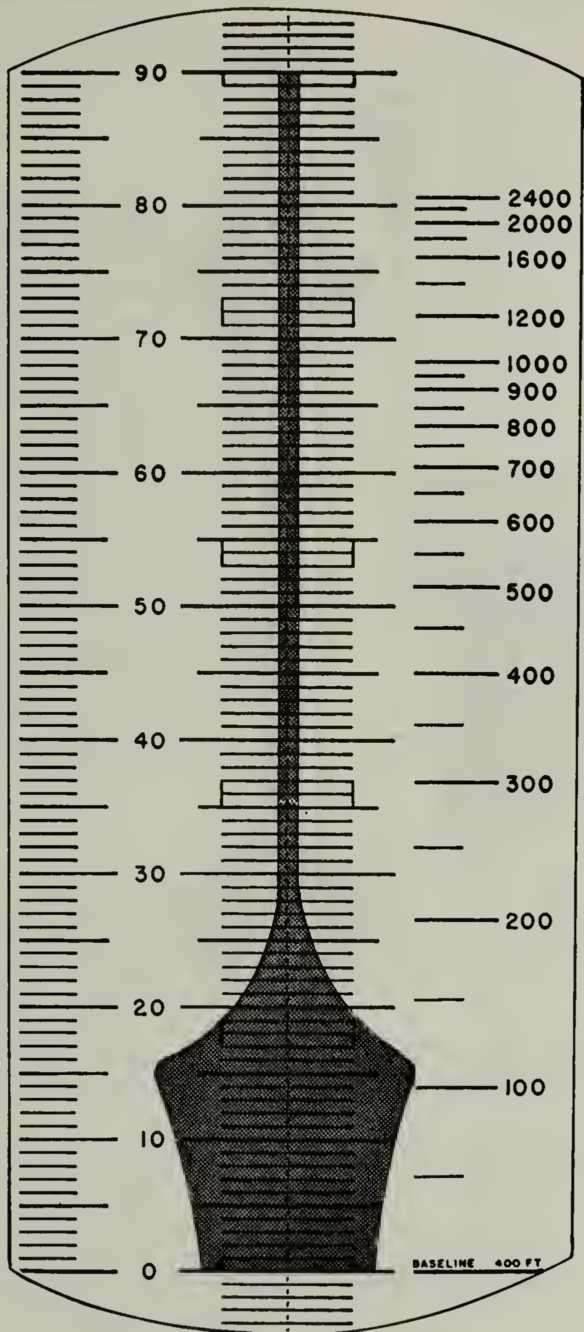
EXERCISE (1-1-11)—Continued



2. a. Angle____________________

   b. Reportable height____________________

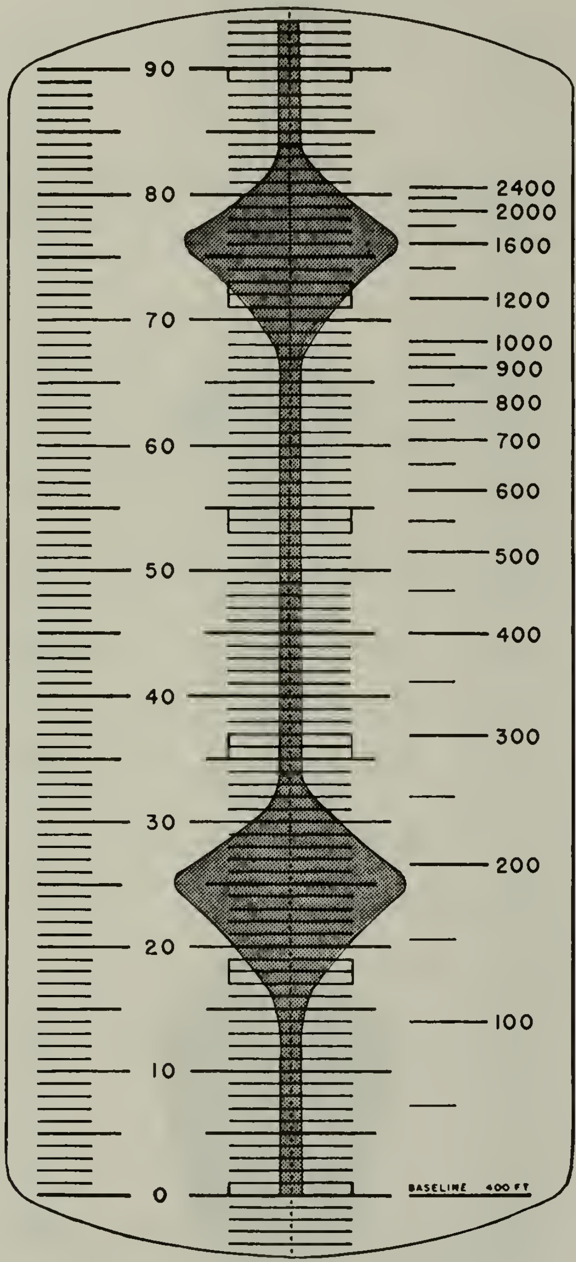
EXERCISE (1-1-11)—Continued



3. a. Angle____________________

b. Reportable height____________________

EXERCISE (1-1-11)—Continued



4. a. Angle________________________

b. Reportable height__________________

Learning Objective: State when a ceiling light can be used to determine ceiling heights, and list the six steps in determining these heights with a clinometer (ML-119).

Ceiling Light Projector (ML-121)

Most weather offices have a ceiling light. A ceiling light is a fixed installation consisting of a powerful incandescent lamp with a reflector system and focusing arrangement housed in a weatherproof drum. It projects a concentrated beam of light vertically upon the cloud base (or into a surface-based obscuring phenomena) so that the observer, located at a measured distance from the projector and sighting with a clinometer (ML-119), can determine the cloud height from the angle of inclination indicated by the clinometer (figure 1-1-14). The ceiling light can be used to determine nighttime sky cover heights and vertical visibility. In order for you to determine a cloud height with the ceiling light, cloud(s) must be directly over the projector beam. When clouds are scattered, or where clearing exists, especially over the observation site, eye estimation must be made.

Clinometer (ML-119)

The clinometer is a lenseless sighting tube, resembling a beer bottle, with crossed wires at its larger end and a quadrant plate assembly which is graduated in 1° intervals from 0° to 90° (see figure 1-1-14). To determine the cloud height from the clinometer, use the following procedures:

1. Loosen the pendant clutch on the quadrant plate to allow the pendant to swing freely.

2. Sight through the clinometer and center the intersection of the cross-hair upon the brightest portion of the light beam spot on the cloud base. When the sky is completely obscured by a surface-based layer, sight on the upper limit of the light beam penetration.

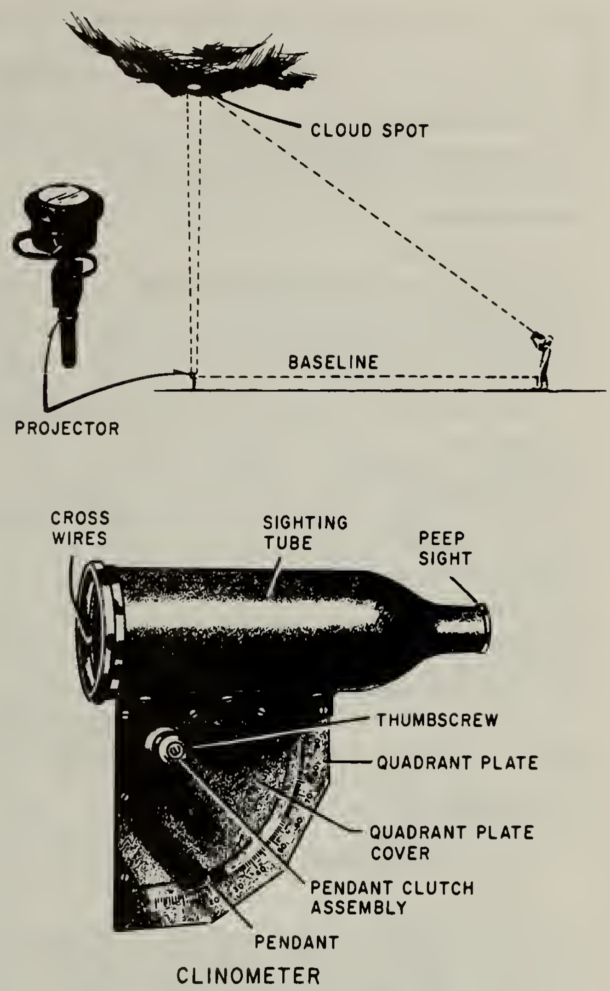


Figure 1-1-14.—Ceiling Light Projector and Clinometer.

3. When the pendant has come to rest, lock it in position without moving the clinometer.

4. Read the indicated angle to the nearest whole degree and release the pendant clutch.

5. Repeat steps 1 through 4 three times and determine an average angular reading.

6. Refer to a prepared table applicable to the baseline used for the equivalent height value of this average reading.

Table 1-1-6.—METAR Cloud and Obscuring Phenomena Types

Clouds	Abbreviations
Altocumulus	AC
Altocumulus Castellanus	ACCAS
Altocumulus (standing lenticular)	ACSL
Altostratus	AS
Cirrocumulus	CC
Cirrocumulus (standing lenticular)	CCSL
Cirrostratus	CS
Cirrus	CI
Cumulonimbus	CB
Cumulonimbus Mamma (Mammatocumulus)	CBMAM
Cumulus	CU
Cumulus Fractus	CUFRA
Nimbostratus	NS
Stratocumulus	SC
Stratocumulus (standing lenticular)	SCSL
Stratus	ST
Stratus Fractus	STFRA
Towering Cumulus	TCU
Obscuring Phenomena	
Precipitation:	
Drizzle (including FZDZ)	DZ
Hail	GR
Ice Crystals	IC
Ice Pellets and Snow Pellets (including PESH)	PE
Rain (including RASH and FZRA)	RA
Snow (including SNSH)	SN
Snow Grains	SG
Hydrometeors other than Precipitation:	
Blowing Snow	SN
Fog (including BR, BCFG, and FZFG)	FG
Lithometeors:	
Haze or Dust	HZ
Sandstorm, duststorm, or blowing dust or sand	SA
Smoke	FU

NOTE: This table lists the two-letter abbreviations used to report type of phenomena in sky conditions. In addition, it lists the abbreviations used to report clouds and obscuring phenomena in Remarks of an observation.

EXERCISE (1-1-12)

1. **When can a ceiling light be used to determine ceiling heights?**

2. **List the six steps used in determining cloud heights with a clinometer (ML-119).**

Learning Objective: Given simulated data, indicate the entries for sky condition using the METAR code.

Sky Condition (Column 3, MF 1-10)

Enter each surface-based obscuration and/or each obscuring phenomena aloft as a six-character group ($N_sCCh_sh_sh_s$) in ascending order. No entry is made when sky is clear.

AMOUNT (N_s).—For each individual layer, enter amounts to the nearest eighth (except enter "9" for a totally obscured sky). Estimate the amount of each layer without consideration for other layers.

Enter traces of clouds as one-eighth and overcast with breaks as seven-eighths.

When two or more types of phenomena occur with bases at the same level, the amount entered will refer to the total of all types at that level except when cumulonimbus is one of the clouds and it does not represent the greatest amount.

TYPE (CC).—Enter type of obscuring phenomena or cloud using the appropriate two-letter abbreviation from table 1-1-6.

When two or more types of phenomena occur with bases at the same level, enter the type that represents the greatest amount, or, if equal amounts, enter type considered more significant.

When cumulonimbus-type clouds are observed at the same level as other cloud types, and do not represent the greatest amount, enter each type in separate cloud groups (e.g., 3/8 clouds observed at 3,000 feet consisting of 1/8 cumulonimbus and 2/8 cumulus, enter 1 CB 030 2 CU 030).

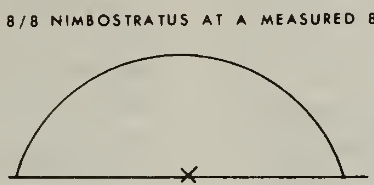
HEIGHT ($h_sh_sh_s$).—Enter height of layer (vertical visibility for obscured condition) using code figures from table 1-1-7. Enter /// for partially obscured conditions.

Table 1-1-7.—METAR Reportable Values for Layer Heights

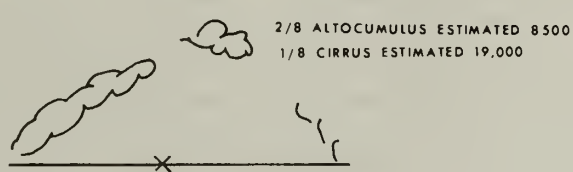
Code	Feet	Meters	Code	Feet	Meters	Code	Feet	Meters
000	0-50	0-15	030	3,000	900	100	10,000	3,000
001	100	30	031	3,100	930	110	11,000	3,300
002	200	60	032	3,200	960	120	12,000	3,600
003	300	90	033	3,300	990	130	13,000	3,900
004	400	120	034	3,400	1,020	140	14,000	4,200
005	500	150	035	3,500	1,050	150	15,000	4,500
006	600	180	036	3,600	1,080	160	16,000	4,800
007	700	210	037	3,700	1,110	170	17,000	5,100
008	800	240	038	3,800	1,140	180	18,000	5,400
009	900	270	039	3,900	1,170	190	19,000	5,700
010	1,000	300	040	4,000	1,200	200	20,000	6,000
011	1,100	330	041	4,100	1,230	210	21,000	6,300
012	1,200	360	042	4,200	1,260	220	22,000	6,600
013	1,300	390	043	4,300	1,290	230	23,000	6,900
014	1,400	420	044	4,400	1,320	240	24,000	7,200
015	1,500	450	045	4,500	1,350	250	25,000	7,500
016	1,600	480	046	4,600	1,380	260	26,000	7,800
017	1,700	510	047	4,700	1,410	270	27,000	8,100
018	1,800	540	048	4,800	1,440	280	28,000	8,400
019	1,900	570	049	4,900	1,470	290	29,000	8,700
020	2,000	600	050	5,000	1,500	300	30,000	9,000
021	2,100	630	055	5,500	1,650	310	31,000	9,300
022	2,200	660	060	6,000	1,800	320	32,000	9,600
023	2,300	690	065	6,500	1,950	330	33,000	9,900
024	2,400	720	070	7,000	2,100	340	34,000	10,200
025	2,500	750	075	7,500	2,250	350	35,000	10,500
026	2,600	780	080	8,000	2,400	etc.	etc.	etc.
027	2,700	810	085	8,500	2,550	990	99,000	29,700
028	2,800	840	090	9,000	2,700	999	100,000	30,000
029	2,900	870	095	9,500	2,850		or more	or more

EXERCISE (1-1-13)

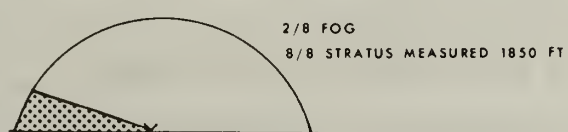
Indicate the entries for sky conditions in METAR code for following illustrations:



1. ______________________________



2. ______________________________



3. ______________________________

VISIBILITY

Visibility, as well as ceiling height, aids in decisions involving air traffic control. For this reason, the observation of visibility must be timely, accurate, and representative. There are four types of visibility that you must consider: (1) prevailing, (2) sector, (3) differing level, and (4) runway visual range.

Learning Objective: Given descriptions of visibility markers, distinguish between those most suitable for day use and those most suitable for night use.

Visibility Markers

Suitable objects must be used in determining visibility. In order for visibility observations to be representative, you must select visibility markers which meet certain criteria.

DAYTIME MARKERS.—The most suitable and useable daytime markers are prominent dark colored objects which can be observed in silhouette against a light-colored background, preferably the horizon sky.

MARKER SIZE.—An object should subtend an angle of not less than 0.5 degree above the horizon, as viewed from the point of observation.

NIGHTTIME MARKERS.—The most desirable night-visibility markers are unfocused light of moderate intensity. The red or green lights of airway beacons and TV or radio tower obstruction lights may be used. Because of their intensity, focused lights of airway beacons should not be used; however, their brillance may serve as an aid in estimating whether the visibility is greater or less than the distance to the light source.

EXERCISE (1-1-14)

From the following list of visibility markers, indicate those best suitable for night markers by inserting an N for night markers and a D for day markers.

1. ________A red light marker on a large building.

2. ________A dark brown house.

3. ________A line of trees.

4. ________A beacon light on a naval air station.

5. ________A white farm house and barn.

6. ________Smoke stack of a manufacturing plant.

7. ________Red light on top of a TV tower.

8. ________A church steeple.

Learning Objective: State the requirements for reporting sector and differing level visibility; and given drawings and descriptions, determine correct entries and given drawings and descriptions, determine correct entries and remarks for reporting visibility.

Prevailing Visibility

Prevailing visibility is the greatest distance that known objects can be seen and identified throughout half or more of the horizon circle that surrounds the station. To aid you in determining the prevailing visibility, most weather offices maintain a visibility chart, or list, that identifies objects suitable for visual sightings. Size and color are used to determine which objects will be selected.

Unfortunately, objects that meet these requirements are not always present in every direction. When this happens, the station uses all available objects. However, if your station is such that your view of portions of the horizon are obstructed by trees, buildings, etc., you can use the control tower values of prevailing visibility as a guide in determining your prevailing visibility. For example, the presence of a surface-based obstruction to vision that is uniformly distributed to heights above the level of the control tower is sufficient reason for evaluating your prevailing visibility as that of the control tower. If your station falls in this category, you must reevaluate your prevailing visibility, as soon as practicable, upon notification of a differing control tower value or of a reportable change at control tower level.

Entries and Remarks

Column 4 (MF 1-10) is where you enter the prevailing visibility. It is entered in statute miles ashore and nautical miles on Navy ships. Use the reportable values listed in table 1-1-8. The

Table 1-1-8.—Reportable Visibility Values (Miles)

Increments of Separation (Miles)						
1/16	1/8		1/4	1		5
0	3/8	1 1/4	2	3	10	15
1/16	1/2	1 3/8	2 1/4	4	11	20
1/8	5/8	1 1/2	2 1/2	5	12	25
3/16	3/4	1 5/8	2 3/4	6	13	30
1/4	7/8	1 3/4	3	7	14	35
5/16	1	1 7/8		8	15	40
3/8	1 1/8	2		9		etc.

NOTES:
1. Prevailing visibility is reported in statute miles at land stations and in nautical miles on naval ships and ocean-station vessels. If the visibility is halfway between two reportable values, enter the lower value.
2. When the prevailing visibility is estimated to be more than the distance of the farthest visibility marker, estimate that visibility to the nearest reportable value.
3. If the prevailing visibility is less than 3 miles and rapidly increases and decreases by one or more reportable values, suffix the average of all the observed values with a V (for variable) and enter the range of variability in remarks.
4. If the prevailing visibility is 4 miles or less, and a different prevailing visibility is reported from a location other than the offical observation site enter this differing visibility in remarks.

column 4 entry represents the prevailing ground level visibility taken at the observer's natural height from as many established observation points as necessary to view the entire horizon. The only other entry in column 4 is made where there is a variable visibility. In this case, the letter "V" is affixed to the prevailing visibility entry to give an entry such as "1 1/4 V." All other entries relating to prevailing visibility go in column 13.

Variable Visibility

Note 3 of table 1-1-8 outlines the rule for reporting rapidly changing prevailing visibility at observation time. When you take a visual sighting on markers less than three miles away and the markers seem to appear and disapear alternately indicating an increasing and decreasing visibility, don't panic. Decide whether the visibility varies by one or more reportable values. At the same time note all of your observed values, average them, and if your average is less than a reportable value of three miles, report the visibility as variable. This simply means that you place the average value in column 4 and affix a "V" to it. This average value, of course, represents the prevailing visibility that is common throughout half or more of the horizon circle.

The contraction "VSBY" identifies column 13 remarks that pertain to visibility. The column 13 variable visibility remark explains the range of the variable visibility. Remember that when visibility is variable, the prevailing visibility entry in column 4 is an average. Therefore, the column 13 remark defines the high and low visibility observed. A remark of "VSBY 1V2" means the visibility is varying between one and two miles. The reportable visibility values from table 1-1-8 are used in column 13 remarks.

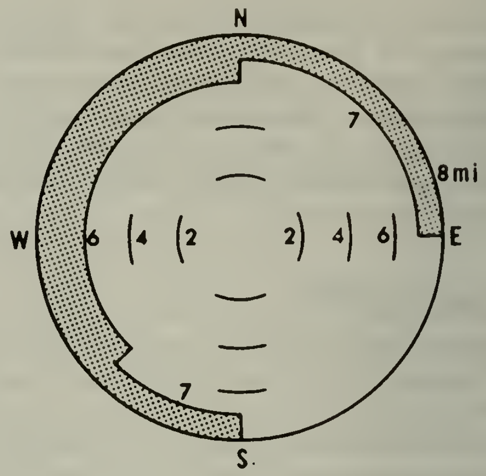


Figure 1-1-15.—Sector Visibility.

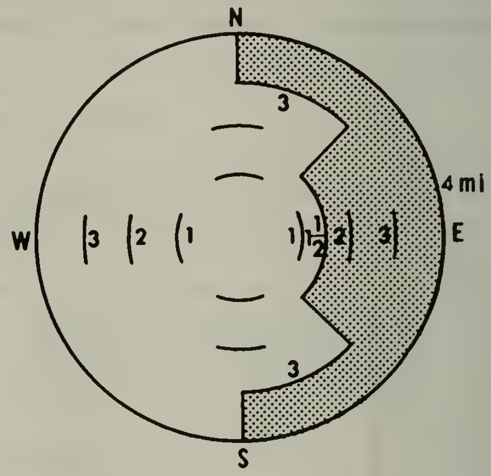


Figure 1-1-16.—Sector Visibility.

Sector Visibility

Sector visibility is actually a part of determining prevailing visibility. Sector visibility points out a part of the horizon where the visibility is uniform. When observing visibility, divide the horizon circle into a few or as many parts as you need to separate the different sector visibilities. Figure 1-1-15 illustrates a horizon that is divided into four unequal sectors. Each sector presents uniform visibility within itself. For example, from north through east, you can see seven miles, east through south, eight miles, etc. These two sectors together give the prevailing visibility of seven miles. The number of sectors you need depends upon the uniformity of the horizon visibility.

Sector visibility sometimes requires an explanation or remark. Refer to figure 1-1-16 and determine the prevailing visibility. The greatest distance seen throughout the western

half of the circle is four miles, the prevailing visibility. Imagine a pilot's surprise if he approaches the field from the east. The entire sector from northeast to southeast has a 1/2-mile visibility. This sector is significant because of two criteria. First, sector visibility is reported when the sector visibility differs from the prevailing visibility, and second, when the sector has a visibility of less than three miles.

There is one more point that you need to consider concerning the significance of sector visibility. Suppose the sector visibility differs from prevailing visibility but is more than three miles (see figure 1-1-17). Both criteria for reporting sector visibility are not met, but the difference is operationally significant. Operational significance is a legitimate reason for entering a remark on a sector visibility. Otherwise, with a prevailing visibility of seven or more miles, no hint of an obstruction to vision is contained in the observation. Suppose there is a north-south active runway in figure 1-1-17. The four-mile visibility in the north will go unnoticed unless you make an operationally significant remark to alert the pilot of the visibility in that sector. Therefore, when a sector visibility of three miles or more differs from the prevailing visibility, and you consider the difference operationally significant, enter a sector visibility remark.

When sector visibility reporting requirements are met, the sector visibility remarks are entered in column 13. Sector remarks define direction and the visibility in the sector, such as VSBY E 1 1/2, as shown in figure 1-1-16. Eight compass points are used to identify sector direction: N, NE, E, SE, S, SW, W, and NW.

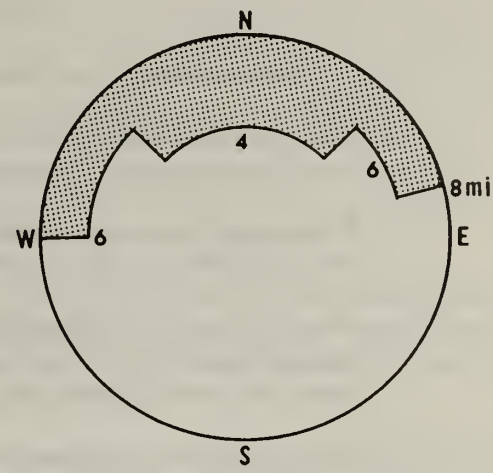


Figure 1-1-17.—Sector Visibility.

Intermediate directions (NNE) can also be used if necessary, although most directions can be described by the eight compass points. When more than one sector needs reporting, list the sectors in a clockwise direction.

Differing Level Visibility (Note 4, Table 1-1-8)

To report differing level visibility, the prevailing visibility must be four miles or less in column 4 and a different prevailing visibility is reported from a location other than the official observation site. This other location is normally the control tower. Enter in column 13 the location from which the observation was made, the contraction "VSBY," and the visibility value; i.e., TWR VSBY 3.

EXERCISE (1-1-15)

1. Give the meaning of the term "prevailing visibility."

2. Under what conditions can you use control tower values of prevailing visibility as a guide in determining the prevailing visibility for column 4?

3. When reporting sector visibility, how many compass points are normally used to identify sector directions? What are they?

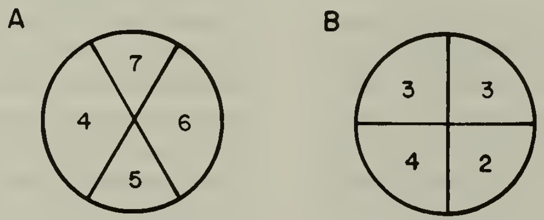
4. When taking a prevailing visibility observation, you will find the visibility varying from 5/8 to 1 1/2 to 3/4 to one mile. What entries would you make in column 4 and column 13 of MF 1-10?

5. What are the two requirements that must be met to report sector visibility?

6. Your prevailing visibility entry in column 4 is four miles. The tower informs you that they can see two miles. What remark, if any, would you make on MF 1-10 and where would you enter it?

7. When reporting sector visibility and more than one sector needs to be reported, how are the sectors listed in column 13?

8. If sector visibility differs from prevailing visibility, but is more than three miles, can you report visibility in column 13 and, if so, why?



9. Indicate the appropriate entries for prevailing and sector visibility (as required) from the above diagram.

Learning Objective: Indicate the annotations required on the transmissometer recorder chart; and from a simulated transmissometer chart and, using a conversion table, determine the reportable RVR.

Runway Visual Range (RVR)

The fourth type of visibility you must consider is runway visual range. RVR is determined from the transmissometer (AN/GMQ-10). The transmissometer(s) are located alongside and about 14 feet higher than the centerline of the runway(s) officially designated for the

reporting of RVR in longline transmissions. Generally speaking, a "designated RVR runway" is any runway which has been instrumented with a transmissometer. The transmissometer provides you with the maximum distance, in the direction of takeoff or landing, at which the runway, or specified lights or markers along the runway, can be seen at a height corresponding to the average eye-level of the pilot at touchdown. In order to accurately report RVR, you should be familiar with the operation of the transmissometer.

Transmissometer (AN/GMQ-10)

The transmissometer operates on the principle of a beam of light directed at a light-sensitive photocell. This photocell is sensitive to the amount of light that it receives and, therefore, registers any reduction in the amount of this light. An obstruction, such as rain, fog, or haze between the projector and detector reduces the amount of light the photocell receives. The percentage of reduction (transmissivity) is converted by tables into linear visibility values.

OPERATION.—The transmissometer(s) is/are operated continuously. At low transmission readings, less than 15 percent, the transmissometer offers an expanded scale feature. Place the transmissometer range switch in HIGH mode when transmissivity is less than 15 percent. This action simply multiplies by five the value indicated by the pen. A 10-percent value at LOW range becomes a 50-percent value in HIGH range. The important point about HIGH mode is to divide the indicated value by five before converting to a reportable runway visibility. Switching to HIGH mode does not increase the sensitivity of the set. The same amount of projected and detected light applies to either mode. Your chances for accurately reading the low scale values improve with the expanded scale.

TRANSMISSOMETER RECORDER CHART.—The recorder chart roll provides a permanent record of approach visibility. The chart roll is graduated horizontally for time and vertically for transmissivity. A chart roll lasts for approximately 15 days. You must remember to change the chart as necessary to prevent loss of data. It is also important to remember that the recorder chart is driven by an eight-day clock; therefore, you should check it during your watch to ensure that it is wound and running. If the clock stops, the chart will not move; that causes the pen to overprint in one spot, and you lose important data.

ANNOTATION OF TRANSMISSOMETER RECORDER CHART.—Each transmissometer recorder chart must display the following entries (figure 1-1-18):

1. A time check and date-time group at the beginning and ending of each chart roll.

2. A time check and date-time group at the actual time of each six-hourly observation.

3. A time check and date-time group at the beginning and ending of maintenance shutdowns or other periods of inoperation.

4. A time check and date-time group when you are notified of any aircraft mishap occurring at, or within, the vicinity of your station.

5. When the chart time differs from the actual time by more than five minutes, note the time of adjustment and enter a new time check on the chart.

6. When the chart or any part of the chart is provided for special studies, an aircraft accident investigation, etc., enter other identification as necessary; e.g., station name, runway number, and length of the transmissometer baseline.

DAY AND NIGHT CONVERSION TABLES.—In determining RVR from the transmissometer, you must be able to select the appropriate time for changing from day to night values or vice versa. In general, the day conversion table values (table 1-1-9) should be used in the evening until low intensity lights on or near the airfield complex are clearly visible, and the night conversion table values should be used in the morning until these lights begin to fade.

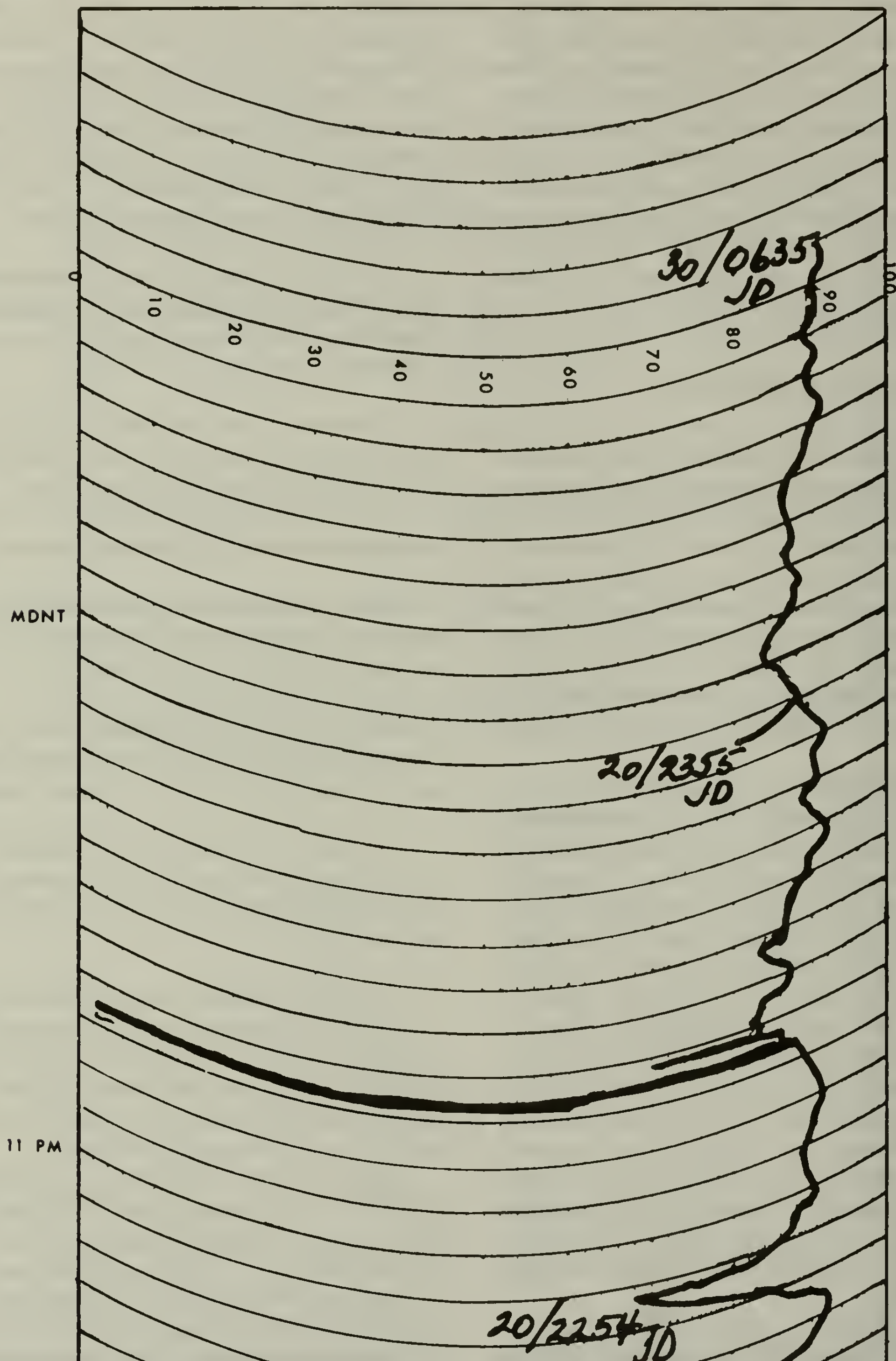


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Figure 1-1-18.—Transmissometer Chart Strip Showing Annotations.

Table 1-1-9.—RVR-Transmissometer Conversion Table for a 500-foot Baseline

NIGHT

RVR Mtrs	RVR (Ft)	LS 5	LS 4	LS 3	Other
M0300	1000–				
----------------		.001	.003	.007	.016
0300	1000				
----------------		.005	.010	.022	.037
0360	1200				
----------------		.013	.024	.044	.065
0420	1400				
----------------		.025	.043	.074	.098
0490	1600				
----------------		.042	.067	.108	.134
0550	1800				
----------------		.062	.095	.145	.171
0610	2000				
----------------		.085	.124	.183	.207
0670	2200				
----------------		.109	.155	.220	.242
0730	2400				
----------------		.135	.186	.257	.276
0790	2600				
----------------		.161	.217	.292	.308
0850	2800				
----------------		.187	.247	.326	.338
0910	3000				
----------------		.213	.276	.358	.366
0970	3200				
----------------		.239	.305	.389	.393
1030	3400				
----------------		.263	.331	.417	.418
1100	3600				
----------------		.287	.357	.444	.444
1160	3800				
----------------		.310	.382	.469	.469#
1220	4000				
----------------		.349	.422	.509	.509#
1370	4500				
----------------		.399	.473	.560	.560#
1520	5000				
----------------		.444	.517	.603	.603#
1670	5500				
----------------		.484	.557	.640	.640#
1830	6000				
----------------		.520	.591	.672	.672#
P1830	6000+				

DAY

RVR Mtrs	RVR (Ft)	LS 5	LS 4	LS 3	Other
M0300	1000–				
----------------		.039	.095	.200	.200
0300	1000				
----------------		.084	.175	.268	.268
0360	1200				
----------------		.140	.261	.328	.328
0420	1400				
----------------		.201	.343	.380	.380
0490	1600				
----------------		.261	.419	.426	.426
0550	1800				
----------------		.319	.466	.466	.466
0610	2000				
----------------		.373	.501	.501	.501
0670	2200				
----------------		.422	.532	.532	.532
0730	2400				
----------------		.468	.560	.560	.560
0790	2600				
----------------		.509	.584	.584	.584
0850	2800				
----------------		.547	.606	.606	.606
0910	3000				
----------------		.581	.626	.626	.626
0970	3200				
----------------		.612	.644	.644	.644
1030	3400				
----------------		.640	.661	.661	.661
1100	3600				
----------------		.665	.676	.676	.676
1160	3800				
----------------		.689	.689	.689	.689
1220	4000				
----------------		.711	.711	.711	.711
1370	4500				
----------------		.737	.737	.737	.737
1520	5000				
----------------		.759	.759	.759	.759
1670	5500				
----------------		.777	.777	.777	.777
1830	6000				
----------------		.793	.793	.793	.793
P1830	6000+				

NOTES:

1. This table is used at locations where airfield minima are published in feet.
2. Before entering this table with transmissivity value:

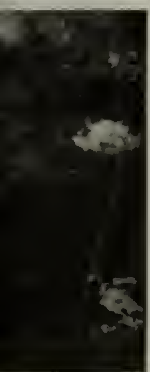
   a. Subtract background illumination.
   b. Divide by five if value was obtained while in HIGH mode.

3. Use column labeled "Other" when runway lights are inoperative or otherwise not available (also, see paragraph 6.2.4e).
4. Values identified by "#" were adjusted to accomplish necessary compatibility between respective equations.

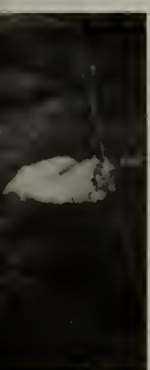
EXERCISE (1-1-16)

1. When do you place the transmissometer switch in HIGH mode?
2. Why is to important to remember to perform a mathematical function to your transmissivity reading when the set is operating in HIGH mode?

•



ather.



umulus.

L 8

10. Cumulus congestus and stratocumulus.

L 9

11. Cumulonimbus capillatus.

L 9

12. Cumulonimbus capillatus.

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L1

1. Cumulus humilis.

L2

2. Cumulus congestus.

L2

3. Cumulus congestus.

L3

4. Cumulonimbus calvus.

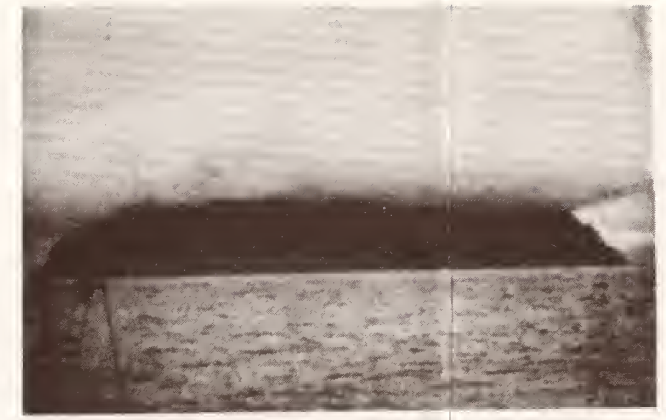
L4

5. Stratocumulus cumulogenitus.

L5

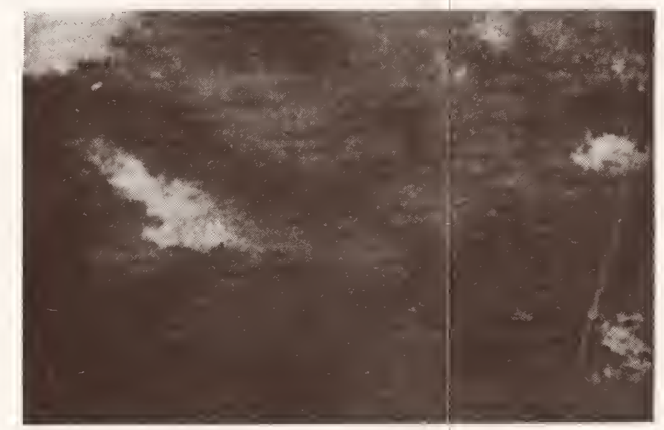
6. Stratocumulus.

L6



7. Stratus.

L7



8. Cumulus fractus of bad weather.

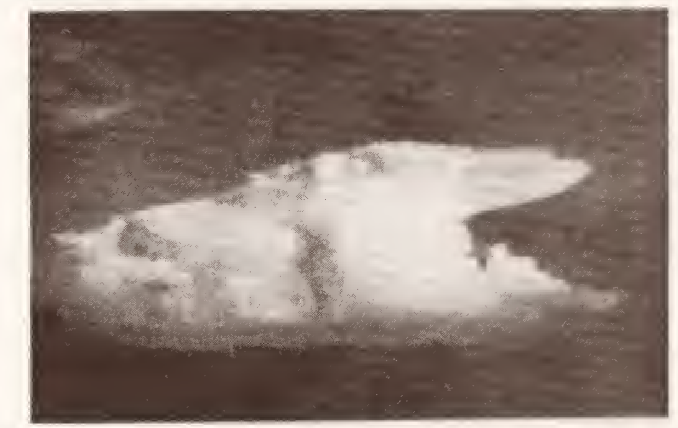
L8

9. Cumulus humilis and stratocumulus.

L8

10. Cumulus congestus and stratocumulus.

L9



11. Cumulonimbus capillatus.

L9

12. Cumulonimbus capillatus.

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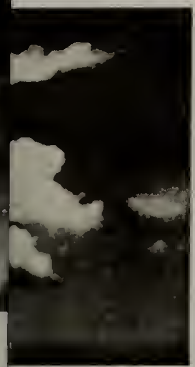
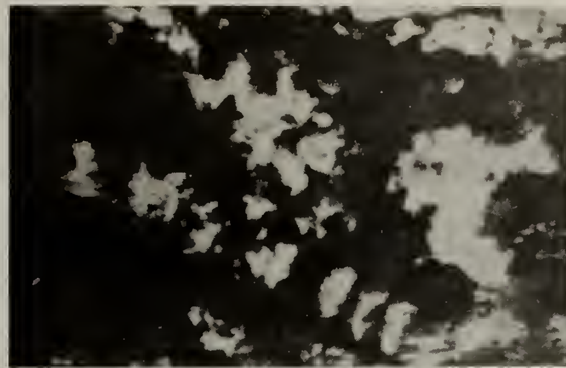
1-1-63



45°.

ogenitus.

M 8

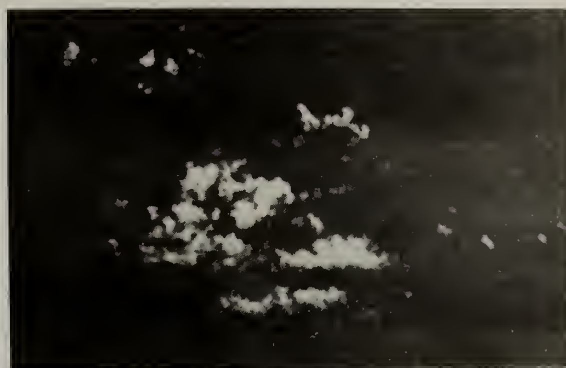


22. Altocumulus floccus.

45°.

atus.

M 8



23. Altocumulus castellanus.

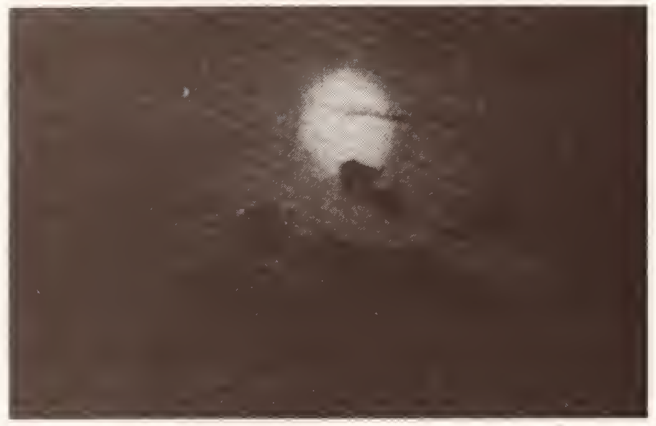
e wh

us.

M 9

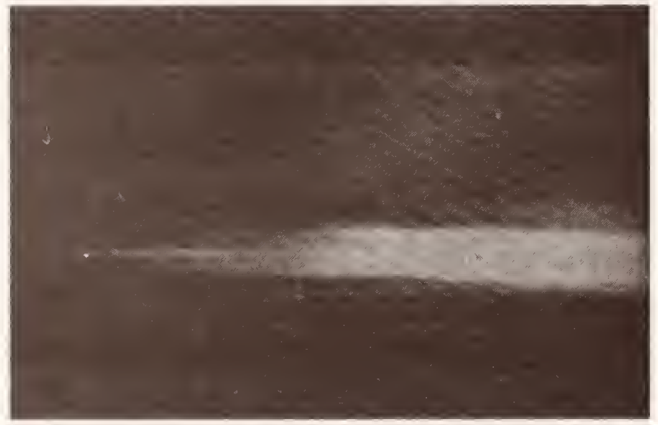
24. Altocumulus of a chaotic sky.

M 1



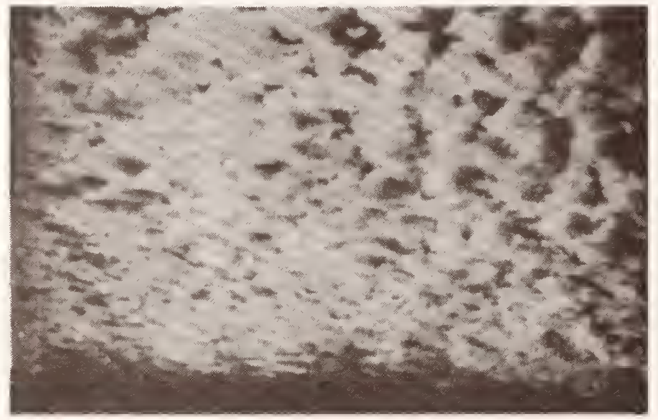
13. Altostratus translucidus.

M 2



14. Altostratus opacus.

M 3

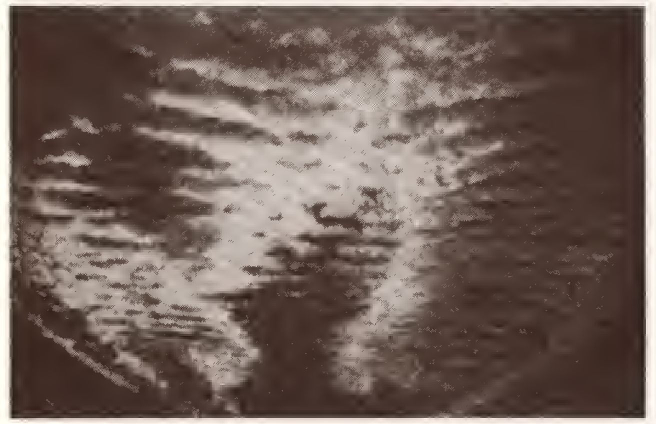


15. Altocumulus translucidus.

M 4

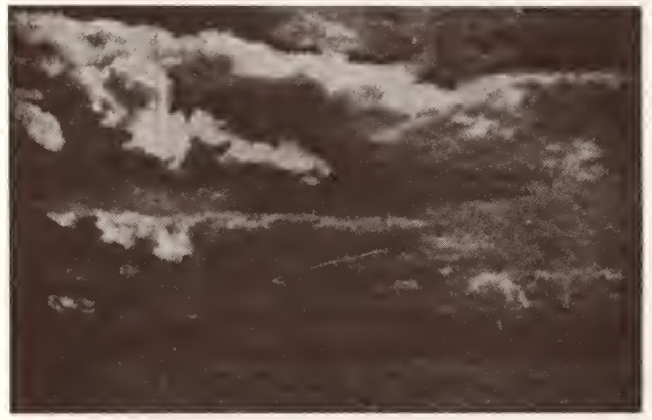
16. Altocumulus lenticularis.

M 5



17. Altocumulus translucidus undulatus.

M 6

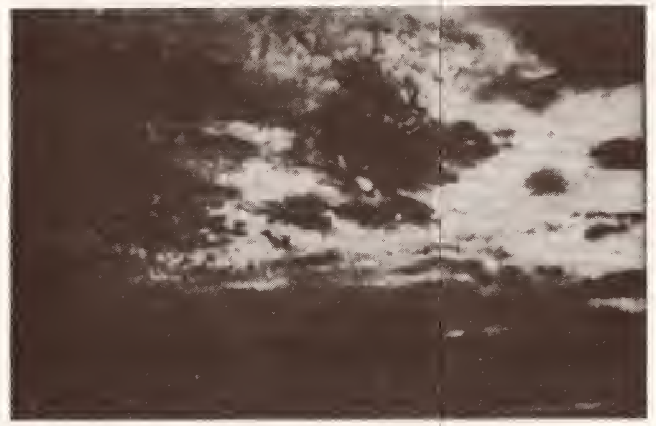


18. Altocumulus cumulogenitus.

M 6

19. Altocumulus cumulonimbogenitus.

M 7

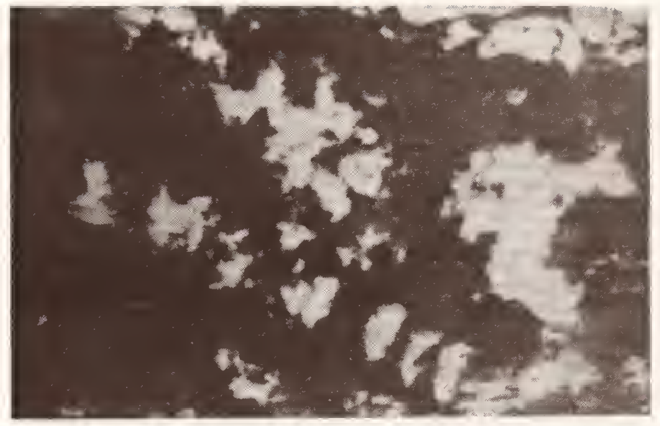


20. Altocumulus duplicatus.

M 7

21. Altocumulus opacus.

M 8



22. Altocumulus floccus.

M 8

23. Altocumulus castellanus.

M 9

24. Altocumulus of a chaotic sky.

45°.

H 8

34. Cirrostratus not covering the whole sky.

45°.

H 8

35. Cirrostratus not covering the whole sky.

e whole sky.

H 9

36. Cirrocumulus.

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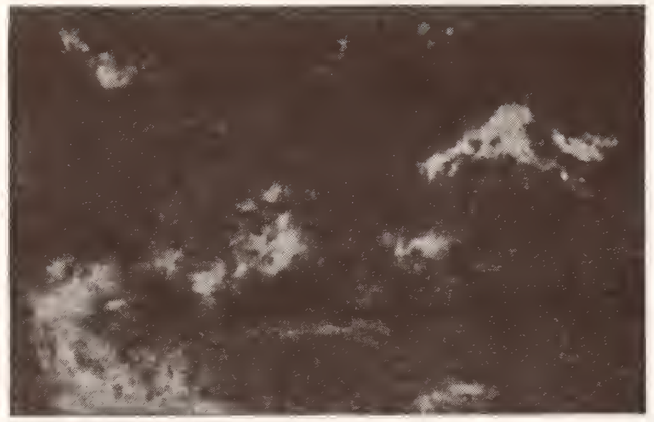
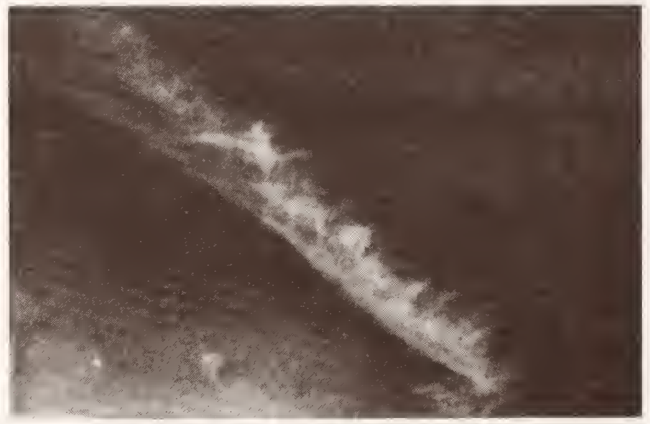
1-1-67

H 1



25. Cirrus fibratus

H 1

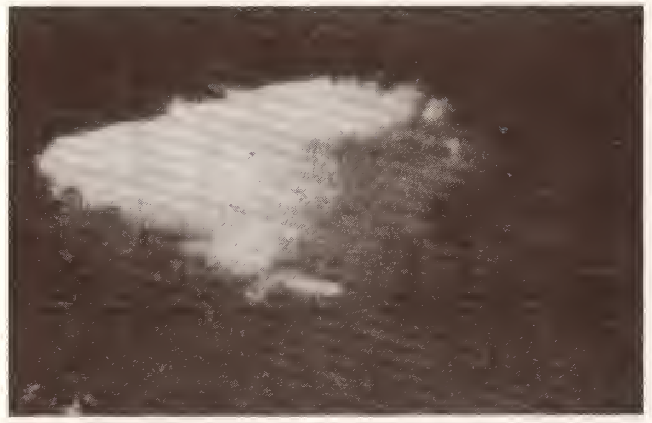


26. Cirrus fibratus floccus.

H 2

27. Cirrus spissatus.

H 3



28. Cirrus spissatus cumulonimbogenitus.

H 3

29. Cirrus spissatus cumulonimbogenitus.

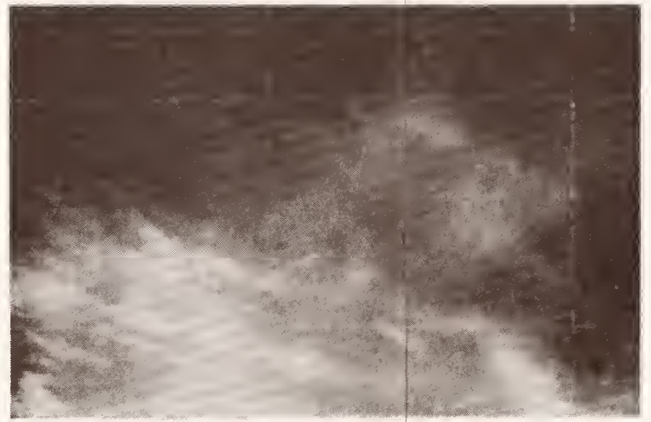
H 4

30. Cirrus uncinus.

H 5

31. Cirrus below 45°.

H 6



32. Cirrus above 45°.

H 7

33. Cirrostratus covering the whole sky.

H 8

34. Cirrostratus not covering the whole sky.

H 8

35. Cirrostratus not covering the whole sky.

H 9

36. Cirrocumulus.

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UNIT 1—LESSON 2

WEATHER AND OBSTRUCTIONS TO VISION

<u>OVERVIEW</u>

Identify the meteorological elements (relating to weather and obstruction to vision) and the procedures related to collecting, recording, and preparing surface meteorological observations for transmission.

<u>OUTLINE</u>

Storm Phenomena Entries

Precipitation Entries

Obstruction to Vision Entries

Metar Code Entries

WEATHER AND OBSTRUCTIONS TO VISION

To this point, you have seen how pilots and forecasters can use the sky condition and visibility entries to make decisions. Weather and obstructions to vision entries on Federal Meteorological Form 1-10 (MF 1-10) are not only a continuation of this discussion, but are directly related to sky condition and visibility. The latter, visibility, is determined by the type of weather or obstruction to vision that is present. By knowing the type of phenomenon that is restricting visibility, the forecaster can make a better prediction of the future visibility. The pilot uses this same information to determine what impact, if any, the weather phenomenon will have on his aircraft. For instance, correctly reporting freezing precipitation is of utmost concern to the pilot. His aircraft could develop aerodynamic problems from icing because of this weather phenomenon. This lesson discusses more specifically the way to recognize each weather phenomenon and the way to correctly encode it in your surface weather observation.

Learning Objective: Name tornadic activity from distinguishing features and from simulated reports indicate the entries required on MF 1-10.

STORM PHENOMENA ENTRIES

Though the term ''weather'' is often used in a broad sense, in observing it refers specifically to atmospheric phenomena that are the basis for entry in column 5 of MF 1-10. This section covers storm-related phenomena such as tornadoes, funnel clouds, waterspouts, and thunderstorms.

TORNADO, FUNNEL CLOUD, AND WATERSPOUT

Tornadoes, funnel clouds, and waterspouts are weather phenomena that occur in areas where intense thunderstorm activity is possible. However, they may or may not occur in conjunction with thunderstorms. In any case, they stem from the same cloud form—the cumulonimbus.

This cloud (discussed in Lesson 1) spawns the frontal and airmass thunderstorms which are usually characterized by thunder, lightning, strong wind gusts, heavy rain showers, and sometimes hail.

Under certain conditions, the potentially destructive energy produced within a cumulonimbus mass is released in the form of a whirling vortex beneath the cloud. When the whirling vortex does not reach the ground, it is called a *funnel cloud*; when the vortex, with its low pressure and tremendous winds, touches the ground, it is called a *tornado*. If the vortex descends to the surface over water, it is called a *waterspout*.

The distinguishing feature of a tornado, funnel cloud, or waterspout is a funnel-shaped appendage that hangs from the base of the cloud. Sometimes thunderstorms are in progress at the time the funnel descends, and precipitation prevents easy detection of the funnel cloud or tornado. Depending on the distance from the point of observation, funnel cloud or tornado identification ranges from the obvious to the doubtful. For example, the ragged appearance of cumulus fractus clouds, that are frequently in the area during thunderstorm activity, may suggest a funnel-shaped appendage. Since these cloud elements usually change rapidly in appearance, close observation for a short time usually resolves the question of whether or not a funnel actually exists. Your judgment, based on all available information, is the key ingredient to proper identification.

Column 5

To report a tornado, funnel cloud, or waterspout as present weather, the phenomenon must normally be occurring at the station, at the time of observation. To be considered occurring "at the station" the phenomena must be visible from the observation site. If you observe a tornado, funnel cloud, or waterspout enter the phenomena in column 5 written out in full; i.e., TORNADO, FUNNEL CLOUD, or WATERSPOUT.

Column 13

Significant remarks for storm phenomena provide added information for the entries in column 5. Storm phenomena present a constant threat to the public as well as to flying operations. Your remarks on tornadic activity alert pilots to its location, the direction in which it is moving, and other information that adds to the basic remark. Though this is a discussion of significant remarks to air traffic controllers, you are encouraged to enter any remark that you think is operational.

TORNADO ACTIVITY IN PROGRESS AT THE STATION.—Whenever a tornado, funnel cloud, or waterspout is sighted by station personnel, enter in column 13, the description, distance in nautical miles (if known), location with respect to the station or to a well-known point, and direction of movement; i.e., TORNADO NE MOVG N, FUNNEL CLOUD 5SW OMA MOVG NE. If the initial special observation taken for the beginning and/or ending of tornadic activity was not transmitted on longline teletype, include the time of beginning (B) and/or ending (E) with the most recent remark in the next transmitted observation; i.e., TORNADO B35 W MOVG E, TORNADO E40 MOVD NE, FUNNEL CLOUD B16E19 NW DSIPTD.

TORNADO ACTIVITY REPORTED BY AN OUTSIDE SOURCE.—Tornado activity reported by an outside source as having occurred within the past hour and has not been observed at the station or previously reported, is entered in column 13. Enter the source (or UNCONFIRMED), description, location, direction of movement, and time (GMT) in hours and minutes; i.e., STATE POLICE TORNADO 15W BLV MOVG NE 1608, PILOT FUNNEL CLOUD 10S OMA MOVMT UNKN 1630, UNCONFIRMED TORNADO 15SW BLV MOVG NE 1815.

EXERCISE (1-2-1)

1. What is a whirling vortex that does not reach the ground called?
2. What is a whirling vortex that descends to the surface, over water, called?
3. What is a whirling vortex that touches the ground called?
4. You receive a report froma pilot that he has sighted a funnel cloud at 1630Z, 25 nautical miles southwest of your station (NGU), moving northeast. What entries, if any, would you make in columns 5 and 13 of MF 1-10?

   a. Column 5 ______________________________ .

   b. Column 13 ______________________________ .

5. At 1749Z you take a special observation for the sighting, by you, of a tornado at your station. The tornado is west of your station and moving toward the northeast. You record the observation and transmit it by longline teletype. What entries, if any, would you make in columns 5 and 13 of MF 1-10?

   a. Column 5 ______________________________ .

   b. Column 13 ______________________________ .

6. You take a special observation for the appearance of a funnel cloud at your station. You sighted the funnel cloud southwest of your station at 1630Z, recorded the observation, but did not transmit it longline. At 1635Z the funnel cloud was northeast of your station and receded back into the base of the mammatus cloud. You take a special observation for its ending and transmit it longline. What entries, if any, would you make in columns 5 and 13 of MF 1-10?

   a. Column 5 ______________________________ .

   b. Column 13 ______________________________ .

Learning Objective: State when a thunderstorm can be included in the observation, even though thunder is not heard; and from simulated observational data, write the appropriate column 5 and 13 entries.

THUNDERSTORMS

Thunderstorm activity, though not as serious as tornadoes, presents many hazards to flight operations. For observing purposes, a thunderstorm is present and occurring at the station when:

1. Thunder is first heard.
2. Hail is falling or lightning is observed (in the immediate vicinity of the airfield and the local noise level prevents you from hearing the thunder).

Column 5

Whenever a thunderstorm is in progress, a significant entry is required in

column 5 for intensity. You determine the intensity based on the following characteristics observed within the past 15 minutes:

1. Thunderstorm (T)—Wind gusts less than 50 knots and hail, if any, less than 3/4-inch in diameter.
2. Severe thunderstorm (T+)—Wind gusts of 50 knots or greater, or hail 3/4-inch or greater in diameter.

Column 13

Enter in column 13 the location of each thunderstorm (with respect to the station) to include distance in nautical miles, if known and the direction toward which the storm is moving (or moved), if known. Some examples are:

Special observation: T NW MOVG SE (FIBI)

Record observation: T B50 NW MOVG SE

In these examples, the thunderstorm remark without the beginning time indicates that the special was not transmitted by longline teletype (FIBI); therefore, it has to be sent in the next transmitted observation. The rule for this is: When the initial special observation taken for the beginning and/or ending of thunderstorm activity was not transmitted on longline teletype, include the time of beginning and/or ending, or both, with the most recent remark in the next transmitted observation. When the thunderstorm ends (15 minutes after the last occurrence of thunder, hail, or lightning) enter T and the direction the storm moved. These are examples:

Special observation: T MOVD E

Record observation: T B37E52 MOVD SE

The above remarks are typical examples of thunderstorm ending remarks. The first example shows a thunderstorm that ended at the time of the transmitted special, no ending time was necessary. The second example shows a thunderstorm of short duration and the specials taken to begin and end the thunderstorms were not transmitted via longline teletype.

Lightning (LTG)

Lightning, though not considered as weather, is associated with thunderstorms. Therefore, remarks about the frequency and type of lightning provide useful data to the air traffic controllers and the forecaster. Lightning remarks are made with or without the presence of audible thunder. When a thunderstorm is present, lightning remarks are placed after the associated thunderstorm remarks in column 13. Each lightning remark should contain the *frequency*, *type*, and *direction* from the station (direction need not be reported when it is the same as the thunderstorm with which it is associated). The following contractions are used for lightning remarks:

Frequency

OCNL—Occasional

FQT—Frequent

Type

CC—Cloud to cloud

IC—In cloud

CG—Cloud to ground

CA—Cloud to air

The following examples show how these contractions are used as remarks:

OCNL LTGIC W

FQT LTGCCCG N-E

FQT LTGIC W-NW OCNL LTGCA E

Hail

Whenever thunderstorms and lightning are present hail is very possible. Large hail can cause extensive damage to aircraft structures. When you observe hail at your station, you should include the contraction "A" for hail in column 5 and a remark in column 13. Hail is entered in column 13 usually following your remarks concerning

lightning. Report hail in a special or record special observation whenever it begins or ends, and in all observations taken while it is occurring. Include the time of beginning and/or ending, or both, following the same criteria as you did for thunderstorms and tornadic activity.

The contraction "A" is entered in column 13 followed by the beginning and/or ending times if necessary, and the contraction HLSTO with the diameter in inches of the largest stones; i.e., HLSTO 1/2, AB13E15 HLSTO 3/4.

EXERCISE (1-2-2)

1. **When can a thunderstorm be included in an observation even though thunder is not heard?**

2. **Use the following observational data to make appropriate column 5 and 13 entries.**

   A thunderstorm is in progress at the station. Hail is falling (largest stone is 1 1/2-inches in diameter). Frequent lightning is observed from cloud to ground in the southeast and occasional lightning is observed from cloud to cloud overhead. The storm is overhead and moving toward the southeast. Your observation was transmitted by longline teletype.

   a. **Column 5** ____________________ .

   b. **Column 13** ____________________ .

3. **Use the following observational data to make appropriate column 5 and 13 entries.**

   A thunderstorm began at the station at 2030Z. A special was taken but not transmitted by longline teletype. Thunder was last heard at 2040Z. The thunderstorm moved to the east. There is occasional lightning cloud to cloud east. A record special is taken and transmitted by longline teletype at 2055Z to end the thunderstorm.

   a. **Column 5** ____________________ .

   b. **Column 13** ____________________ .

PRECIPITATION ENTRIES

This section will cover forms, character, intensity, and measurement of precipitation. Precipitation falls in many forms. Generally speaking, the various types are classified into three main forms: liquid, freezing, and solid.

Learning Objective: Given a list of statements concerning precipitation, name the precipitation form described in each.

LIQUID PRECIPITATION

Rain and drizzle are the only two forms of liquid precipitation. Rain is distinguished from drizzle by the size of the water droplet (particle) and the spacing between droplets. Rain droplets have a diameter usually greater than 0.02 inch (0.5mm), whereas drizzle has a droplet size less than 0.02 inch (0.5mm). The drizzle droplets are very close together and appear to float with the air currents. Drizzle usually falls from low stratus clouds and is frequently accompanied by low visibility and fog.

FREEZING PRECIPITATION

Freezing precipitation is liquid precipitation that falls and freezes upon impact with the ground or objects in flight or on the ground. Usually, freezing precipitation is caused by supercooled water particles, but it may occur when the surface is cold enough to freeze water particles that are near freezing. When water particles do freeze upon impact with the ground or objects in flight or on the ground, classify the precipitation as either freezing rain or freezing drizzle.

SOLID PRECIPITATION

For observing purposes, solid precipitation is classified into the following forms:

- Ice pellets
- Hail
- Snow
- Snow pellets
- Snow grains
- Ice crystals.

Ice Pellets

Ice pellets are either transparent or translucent particles of ice which are round or irregular in shape (rarely conical) and have a diameter of 0.2 inch (5mm) or less. Ice pellets are formed by two different processes. If continuous or intermittent (not showers) precipitation (such as rain or melted snowflakes) freezes, the result is a transparent ice pellet (formerly called sleet). Snow pellets that become encased in a thin layer of ice are classified as ice pellets. This occurs when a snow pellet begins to melt and refreeze, or it may occur when snow pellets come in contact with water droplets while falling. In this case the water freezes, producing a thin layer of ice around the snow pellet. This type falls as showers. Ice pellets usually rebound when striking hard ground and make a sound on impact.

Hail

Hail is distinguished from other solid precipitation by its irregular shape and generally large size. Hail falls almost exclusively from strong convective clouds (cumulonimbus) which are usually accompanied by thunder. Some hailstones consist of alternately opaque and clear layers of ice, which are formed by the strong up and down drafts within the cloud. On occasion, hailstones freeze together and fall in irregular lumps. When hail falls at the station, you must determine the size of the largest hailstone that is readily available. Hail seldom occurs when surface temperatures are near or below freezing.

Snow

Snow is precipitation of ice crystals, mostly branched in the form of six-pointed stars. At temperatures higher than about 23° Fahrenheit the crystals are generally clustered to form snowflakes.

Snow Pellets

Snow pellets are white, opaque grains of ice. The grains are round or sometimes conical. Diameters range from about 0.08 inch (2mm) to 0.2 inch (5mm). Snow pellets are brittle and easily crushed. When they strike hard surfaces, they bounce and often break up. When conditions are right, snow pellets serve as the nuclei for hail development. Snow pellets form exclusively in convective clouds which produce showery precipitation.

Snow Grains

Snow grains are very small, white, opaque grains of ice, similar in structure to snow. The primary difference is the smallness of each element and the fairly flat or elongated shape of the snow grains in comparison to snow. They do not burst or shatter when they strike hard surfaces. Snow grains usually fall in small quantities mostly from stratus clouds and never as showers.

Ice Crystals

Ice crystals are unbranched, in the form of needles, columns, or plates. They are often so tiny that they appear to be suspended in the air. Ice crystals may fall from a cloud or from clear air. The crystals are visible mainly when they glitter in the sunshine or other bright light (diamond dust). They may produce a luminous pillar or other optical phenomena. Ice crystals (which are frequently seen in polar regions) occur only at very low temperatures in stable airmasses.

EXERCISE (1-2-3)

1. What are the two forms of liquid precipitation?

2. Define "freezing precipitation."

3. Name the precipitation form described by each of the following statements.

a. ________ Transparent or translucent particles of ice which are round or irregular in shape. They usually rebound when striking hard ground and make a sound on impact.

b. ________ Very small, white, opaque grains of ice that usually fall in small quantities mostly from stratus clouds and never as showers.

c. ________ Ice crystals, mostly branched in the form of six-pointed stars.

d. ________ Falls from strong convective clouds and occasionally freeze together falling in irregular lumps.

e. ________ Unbranched, in the form of needles, columns, or plates.

f. ________ Form exclusively in convective clouds and under the right conditions serve as the nuclei for hail development.

Learning Objective: Identify the three categories of precipitation and classify the intensity of precipitation by rate of fall or visibility criteria.

CHARACTER OF PRECIPITATION

Knowing the type of precipitation that is associated with low ceilings and visibilities is undoubtedly of great benefit to both the pilot and forecaster. This information is made even more meaningful when the character and intensity of

precipitation is added. The pilot is very interested in knowing the presence of rain showers versus rain, because rainshowers tell him to expect a greater fluctuation in visibility as he lands and takes off from an air station. The decision of whether the precipitation is showery or continuous, light or moderate, is determined by the observer's judgment based on experience and established guidelines.

Precipitation character is based upon established criteria. The character of precipitation is divided into three categories:

- Continuous
- Intermittent
- Showery.

Continuous

Continuous precipitation increases or decreases gradually in intensity, if at all. Precipitation of this character is usually associated with stratiform cloud types such as altostratus, nimbostratus, and stratus.

Intermittent

Intermittent precipitation also increases or decreases gradually in intensity. However, to be classified as intermittent, the precipitation must stop and start at least once within the hour preceding the observation. This category of precipitation is used with precipitation types not classified as showery and is indicated by a remark in column 13 (for example, INTMT R –).

Showery

Showery precipitation changes intensity rapidly, or the shower begins or ends abruptly. Swelling cumulus and cumulonimbus clouds produce showery precipitation. When showers have ended at the observation site but are still in progress near the station, this can be indicated by entering an appropriate remark in column 13 (i.e., RWU E, SW OVR MTNS N).

INTENSITY OF PRECIPITATION

Intensity of precipitation is an indication of the amount of precipitation falling at the time of observation. Each precipitation form (with the exception of hail and ice crystals) is suffixed with an intensity symbol. The symbol "–" for light, an omission (no symbol) for moderate, and "+" for heavy. Each intensity is defined with respect to the type of precipitation occurring.

Determine the intensity of precipitation from established standards, such as FMH-1. These standards provide tables which can be used to determine intensities. Tables 1-2-1 through 1-2-4 are reproductions of these tables. Note that tables 1-2-1 and 1-2-4 are used for precipitation other than drizzle. Table 1-2-2 is used for drizzle. Tables 1-2-1 and 1-2-2 are also used to determine the intenisty of snowfall. To improve your judgment in determining intensity of precipitation, observe the precipitation over a period of time. Frequently, the total precipitation (water equivalent) for the day is not supported by the intensities that the observer reports during the day. For example, suppose you, as an observer, carry moderate continuous rain interspersed with short periods of light rain for a six-hour period. At the end of the six-hour period your measurement was only one inch. Since an intensity of moderate for an entire six-hour period should yield more than one inch (based on table 1-2-1), the intensity of moderate carried by you would be in error. Remember that a check of precipitation amounts

Table 1-2-1.—Estimating intensity of precipitation (other than drizzle) on rate-of-fall basis

Light	A trace to 0.10 inch (2.5 mm) per hour; maximum 0.01 inch (0.3 mm) in 6 minutes.
Moderate	0.11 inch to 0.30 inch (2.6 to 7.6 mm) per hour; more than 0.01 inch (0.3 mm) to 0.03 inch (0.8 mm) in 6 minutes.
Heavy	More than 0.30 inch (7.6 mm) per hour; more than 0.03 inch (0.8 mm) in 6 minutes.

Table 1-2-2.—Intensity of drizzle, snow grains, snow pellets, or snow with visibility as criteria

Light	Visibility equal to or greater than 5/8 statute mile, 0.55 nautical mile, or 1,000 meters.
Moderate	Visibility 5/16 to 1/2 statute mile, 0.25 to 0.5 nautical mile, or 500 to 900 meters.
Heavy	Visibility equal to or less than 1/4 statute mile, 0.2 nautical mile, or 400 meters.

NOTE: Use this table to determine intensity when the respective type of precipitation (drizzle, snow, etc.) is occurring alone. When occurring with other precipitation or an obstruction to vision, estimate intensity on a rate-of-fall basis.

Table 1-2-3.—Estimating the intensity of ice pellets

Light	Few pellets falling with little, if any, accumulation.
Moderate	Slow accumulation.
Heavy	Rapid accumulation.

Table 1-2-4.—Estimating the intensity of rain

Light	A trace or more up to a condition in which individual drops are easily seen; slight spray is observed over pavements; puddles form slowly; sound on the roof ranges from a slow pattering to a gentle swishing; steady small streams may flow in gutters and downspouts.
Moderate	Inidividual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces, puddles form rapidly; downspouts on buildings are running 1/4 to 1/2 full; sound on the roof ranges from a swishing sound to a gentle roar.
Heavy	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to a height of several inches is observed over hard surfaces; downspouts run more than 1/2 full; visibility is greatly reduced; sound on the roof resembles the roll of drums or a distant roar.

NOTE: The following guide provides a simplified outline of the above descriptions as an aid in readily estimating intensity.

	INDIVIDUAL DROPS	SPRAY OVER HARD SURFACES	PUDDLES
Light	Easily seen.	Hardly any.	Form slowly.
Moderate	Not easily seen.	Noticeable.	Form rapidly.
Heavy	Not identifiable. Rain in sheets.	Heavy, to a height of several inches.	Form very rapidly.

for a six-hour period and for the day is a good indication of whether or not you are entering the correct intensities.

Whenever more than one form of precipitation is occurring simultaneously, tables 1-2-1 and 1-2-2 provide the guide for determining intensity, provided that you give proper consideration to the relative proportion of each type of precipitation. If your station does not have a recording or totalizing page, but has a standard rain gage, use:

- Table 1-2-2 for drizzle or snow not occurring simultaneously.
- Table 1-2-4 for rain.
- Table 1-2-1 and your experience when snow occurs with obstructions to vision.

EXERCISE (1-2-4)

1. What are the three categories of precipitation?

2. What category of precipitation is usually associated with stratiform cloud types?

3. Swelling cumulus and cumulonimbus clouds produce what category of precipitation?

4. What is the category of precipitation that stops and starts at least once within the hour preceding the observation?

5. What precipitation category changes intensity rapidly or begins and ends abruptly?

6. Using tables 1-2-1 through 1-2-4, classify the intensity of precipitation described by each of the following statements:

a. __________ Snow is falling. There is no obstruction to vision present. The prevailing visibility is 1/4 statute mile.

b. __________ A slow accumulation of ice pellets is falling.

c. __________ Rain is falling. Scattered drops do not completely wet an exposed surface and puddles are forming slowly.

d. __________ Drizzle is falling and there is no obstruction to vision present. The prevailing visibility is one statute mile.

Learning Objective: State the procedures for measuring liquid and solid precipitation; and from simulated data, indicate the water equivalent of precipitation.

PRECIPITATION MEASUREMENT

As the observer, you are required to make some climatological entries on MF 1-10. The column for the measurement of liquid and solid precipitation are 44-46 (Synoptic Data) and 68-70 (Summary of Day Data). The precise

requirements and instructions for making measurement entries in these columns can be found in FMH-1B. Here we will explain how to take these measurements.

Precipitation Gages

Precipitation measurements are made from samples caught in gages, or from samples taken from representative areas when the catch of solid forms in the gage is not representative.

TIPPING BUCKET RAIN GAGE.—The tipping bucket rain gage ML-558 (Figure 1-2-1) is the standard used at most Navy units. This gage was originally designed for use with the AN/GMQ-14( ) Semiautomatic Meteorological Station but has been adapted for use with the AN/GMQ-29( ) Automatic Weather Station. The AN/GMQ-29( ) presents both a digital display and recorded trace of rainfall.

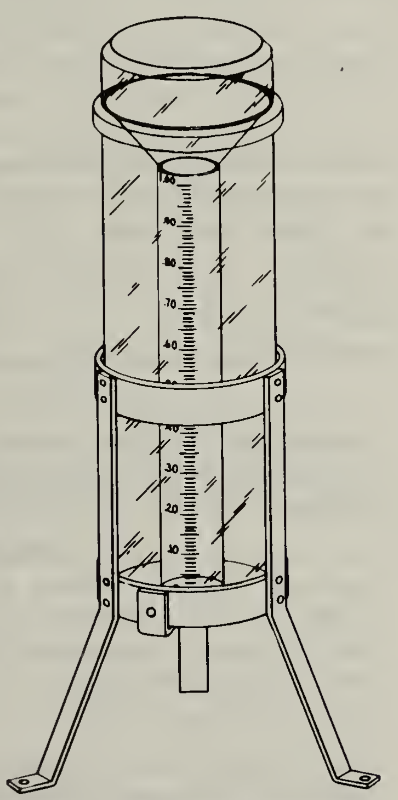
THE ANALOG RECORDER RO-447/GMQ-29( ).—The Analog Recorder is used to record the rainfall amounts. It is recorded on the right side margin of the chart and as an event marker to the left for each 0.01 inch of rain, with every tenth mark (0.10 inch) reversing direction and recording a mark to the right.

At the appropriate time you can use the amount indicated on the digital display and refer to the recorded chart for the times of beginning and ending of precipitation.

FOUR-INCH PLASTIC RAIN GAGE.—The Plastic Rain Gage ML-217 (Figure 1-2-2) is a non-recording measuring instrument designed to measure the depth of precipitation to the nearest 1/100th of an inch. The instrument consists of a measuring tube, collector, overflow can, and

209.400

Figure 1-2-1.—Tipping bucket rain gage ML-558.



209.400A

Figure 1-2-2.—Rain gage ML-217.

accessory tripod support. The overflow can, measuring tube, and collector are made of transparent plastic to permit direct reading of rainfall on the scale imprinted on the measuring tube. The accessory tripod support is made of riveted steel strapping with holes drilled in each mounting foot for attachment to the mounting surface. The measuring tube, visible inside the overflow can, is graduated from zero to one inch of rainfall. Precipitation in excess of one inch runs out of the measuring tube into the overflow can and may be measured by emptying the measuring tube, measuring the overflow in the measuring tube, and adding the measured values to obtain total precipitation.

When solid precipitation is expected, remove the collector-funnel unit and the measuring tube from the overflow can. Since you are interested in determining water equivalents of solid precipitation, melt the contents of the overflow can before measuring the fallen amount. To do this, pour a measured amount of warm water into the can and then pour the resulting liquid into the measuring tube. After measuring the total liquid, remember to subtract the amount of warm water used to melt the solid precipitation. The difference is the water equivalent of the solid precipitation. During snowfall accompanied by strong or gusty winds, the amount of fall collected in the overflow container may not represent actual snowfall. If you think the rain gage collection is not representative, disregard the catch and obtain, if possible, water equivalent by means of core sampling in accordance with Chapter 7 of FMH-1B.

If this procedure is not possible you can estimate the water equivalent. To estimate water equivalent of solid forms of precipitation, first obtain a measurement of the snowfall. Convert the actual depth to its water equivalent on the basis of a 1:10 ratio (or other ratio if known to be representative for the station). For example, if 1.6 inches of snow has fallen, the water equivalent is approximately .16 inch (i.e., 1.6 divided by 10 = .16 by using the 1:10 ratio).

EXERCISE (1-2-5)

1. **What is the procedure for measuring liquid precipitation?**
   a. **Automatic Weather Station**
   b. **Plastic Rain Gage**
2. **What is the necessary procedure to prepare for the measurement of solid precipitation?**
3. **What is the procedure for measuring the water equivalent of snow using the rain gage?**
4. **The measuring tube of the rain gage is full of liquid precipitation. You pour out the contents and find there is some more precipitation in the overflow can. You pour this into the measuring tube and measure an additional .1 of an inch of precipitation. The total measurement for the period is ____ inches.**
5. **Snow is forecast and you remove the collector-funnel and measuring tube from the rain gage. It begins to snow. At the time you have to measure for the water equivalent of the snowfall you pour one half inch (.5) of warm water into the overflow can to melt the snow. You pour the resulting liquid into the measuring tube and measure .65 inch of liquid precipitation. The total measurement of water equivalent for the period is ____ of an inch.**
6. **Due to high winds you determine the rain gage collection of a snowfall is not representative. You cannot take a core sample. You determine 2.2 inches of snow has fallen. You estimate the water equivalent on a 1:5 ratio. The total water equivalent for the period ____ is of an inch.**

Learning Objective: From simulated data, indicate the appropriate additive data entries for precipitation.

RECORDING PRECIPITATION IN COLUMN 13

There are certain specified requirements for entering precipitation amounts in column 13 of MF 1-10.

Six-Hour Precipitation

The amount of precipitation (or water equivalent) in the past six hours is entered as "RR" of the appRR as tenths and hundreds of inches. Encode a trace as "00." Omit RR when no precipitation has occurred. When the amount of precipitation is one inch or more, enter the tenths and hundredths as RR and enter in plain language the number of whole inches. For example, 2.53 inches is entered as app53 TWO.

Snow-Depth (904spsp)

This group is reported at stations transmitting scheduled aviation observations on longline teletype or COMEDS. It is omitted if there is no more than a trace (less than .5 inch) of snow on the ground at the time of observation. When more than a trace of snow is on the ground, encode and report the snow depth in the 1200 GMT observation at stations taking scheduled observations at that time. Encode and report the snow depth in the 0000, 0600, and 1800 GMT observations when more than a trace of snow is on the ground and more than a trace of precipitation (water equivalent) has occurred within the past six-hour period. Encode the tens and units digits of snow depth as "spsp." Include a 90499 group for each 100 inches of snow. For example, 3 inches is encoded as 90403, 99 inches is encoded as 90499, 100 inches is encoded as 90499 90400, 219 inches is encoded as 90499 90499 90419.

There are special requirements for overseas stations and CONUS stations operating less than 24-hours per day. Check FMH-1B for these requirements.

Twenty-Four Hour Precipitation ($2R_{24}R_{24}R_{24}R_{24}$)

This group is reported at stations transmitting scheduled aviation observations on longline teletype of COMEDS. It is omitted if no more than a trace of precipitation (water equivalent) has fallen in the preceding 24 hours. When more than a trace of precipitation (water equivalent) has fallen in the past 24 hours, encode and report the 24-hour precipitation at 1200 GMT. Encode the tens, unit, tenths, and hundreds of inches (water equivalent) for $R_{24}R_{24}R_{24}R_{24}$. For example, encode .12-inch as 20012, and encode 2.53 inches as 20253. If more than a trace of precipitation has occurred and the amount cannot be determined, encode 2////.

There are special requirements for some overseas stations and stations not operating 24-hours per day. Check FMH-1B for these requirements.

EXERCISE (1-2-6)

1. **Indicate the appRR entries for the following six-hour precipitation (water equivalent) measurements:**

   a. **Trace**

   b. **.12-inch**

   c. **2.03-inches**

2. **Indicate the appropriate snow depth entry in column 13 for each of the following:**

   a. **There are five inches of snow on the ground at 1200 GMT.**
   b. **There are nine inches of snow on the ground at 1800 GMT and a trace of precipitation has occured in the past six hours.**
   c. **There are 112 inches of snow on the ground at 0000 GMT, and one inch of precipitation (water equivalent) has fallen in the past six hours.**

3. **Indicate the appropriate entry in column 13 for 24-hour precipitation for the following water equivalent measurements:**

   a. **Trace**

   b. **.12-inch**

   c. **10.02 inches**

OBSTRUCTIONS TO VISION ENTRIES

Obstructions to vision includes all other types of atmospheric phenomena not considered "weather." Since visibility is affected by obstruction to vision phenomena, the forecaster studies reports of these obstructions at his station as well as reports from surrounding stations. Knowledge of this data and the meteorological factors that influence changes to obstructions to vision are extremely important aids in flight operations and scheduling.

All obstructions to vision are classified as either a hydrometeor or lithometeor. They are not entered in column 5 of MF 1-10 unless they restrict visibility of less than seven miles. However, those that you think are operationally significant should be entered as remarks in column 13. In fact, these remarks are encouraged. Remember that when obstructions to vision cover 0.1 or more of the sky, they are considered as sky cover (−X or X).

Learning Objective: List the five hydrometeors and the five lithometeors; and from given descriptions, name the specific obstruction to vision.

HYDROMETEORS

Hydrometeors are atmospheric phenomena that consist of liquid or solid water particles. When these particles are falling, they are called precipitation. When they are suspended in the atmosphere, they are called obstructions to vision.

For observing purposes, there are five hydrometeors that are considered obstructions to vision:

- Fog
- Ground fog
- Blowing snow
- Ice fog
- Blowing spray.

Fog

Fog is a suspension of small water droplets in the air, reducing horizontal visibility at the earth's surface. Fog is distinguished from other obstructions to vision by its dampness and gray appearance. Usually fog does not form or exist when the difference or "spread" between the temperature and dewpoint is greater than 4° Fahrenheit or 2° Celsius; however, it should be reported whenever it is observed. When temperatures are below freezing, the difference may exceed 4° Fahrenheit. Heavy fog sometimes produces rime or glaze ice on cold, exposed objects. To be entered in column 5 fog must have a vertical depth of 20 feet or more.

Ground Fog

Ground fog, on the other hand, is fog that extends to a depth of less than 20 feet. Unless you have some way of measuring the depth, such as known heights of buildings or towers on the base, it will be very difficult to judge the depth of the fog. When in doubt, encode it as fog.

Blowing Snow

Blowing snow exists when the wind blows snow to moderate or great heights. Blowing snow is closely related to drifting snow; the main difference is that blowing snow restricts visibility (six miles or less) and the sky may become obscured when the particles are raised to great heights. Drifting snow does not reduce visibility below seven miles at eye level. Therefore, drifting snow is not entered in column 5 of MF 1-10.

Ice Fog

Ice fog is a rare form of fog, because it usually forms at temperatures below −20° Fahrenheit (−30° Celsius). Ice fog does not produce rime or glaze on cold objects. It consists of elements very similar to ice crystals except that ice fog particles are suspended in the atmosphere. Ice fog produces optical effects that are similar to those produced by ice crystals, such as halo phenomena, lumunous vertical columns, or sparkling effect. Ice fog can form at temperature and dewpoint differences of 8° Fahrenheit (4.5° Celsius) or more.

Blowing Spray

Blowing spray is reported only at sea or stations near large bodies of water. To be reported, the spray, which is water droplets that are blown from the water by the wind, must restrict the visibility at eye level (six feet on shore, 33 feet at sea) to six nautical miles or less.

LITHOMETEORS

All obstructions to vision that do not have a water composition (hydrometeor) and are not classified as "weather" are called lithometeors. They are classified into five separate types as follows:

- Dust
- Blowing dust
- Blowing sand
- Haze
- Smoke.

Dust

Dust is finely divided earthy matter that is uniformly distributed in the atmosphere. You can distinguish it from other lithometeors by the tan or gray tinge that it gives to distant objects. When dust is present, the sun's disk is pale and colorless or has a yellow tinge through the dust.

Blowing Dust

Blowing dust is dust that the wind picks up from the surface and blows about in clouds or sheets. To be classified as blowing dust, it must

restrict horizontal visibility to less than seven miles. In aviation observations the following are also reported as blowing dust:

1. Duststorm—same as blowing dust except visibility is reduced to less than 5/8-mile but not less than 5/16-mile.
2. Severe duststorm—same as blowing dust except visibility is reduced to less than 5/16-mile.

Blowing Sand

Blowing sand is reported when the wind picks up sand from the surface and blows it about in clouds or sheets. To be classified as blowing sand, it must restrict horizontal visibility to less than seven miles. In aviation observations the following are also reported as blowing sand:

1. Sandstorm—same as blowing sand except horizontal visibility is reduced to less than 5/8-mile but not less than 5/16-mile.
2. Severe sandstorm—same as blowing sand except horizontal visibility is reduced to less than 5/16-mile.

Haze

Haze is a suspension in the air of extremely small, dry particles, such as salt, dust, or pollen. They are invisible to the naked eye and sufficiently numerous to give the air an opalescent appearance. In spite of the fineness of haze particles, haze restricts visibility. Over the landscape, haze resembles a uniform veil that subdues the natural colors, such as green trees along the horizon. When viewed against a dark background, such as a mountain, haze produces a bluish tinge. It causes a dirty yellow or orange tinge against a bright background, such as the sun, clouds on the horizon, or snowcapped mountain peaks. When the sun is well above the horizon, its light sometimes has a peculiar silvery tinge because of haze. These color effects distinguish haze from thin fog, even when the thickness of haze approaches that of thin fog.

Smoke

Smoke is a very common obstruction to vision near large cities and industrial areas. It consists of fine ash particles produced by combustion. When the disk of the sun is viewed through smoke at sunrise or sunset, it appears very red. When the sun is above the horizon, it may have an orange tinge. Evenly distributed smoke from distant sources generally has a light grayish or bluish appearance. A transition to haze may occur when smoke particles have traveled great distances; for example, 25 to 100 miles or more, and when the larger particles have settled out and the remaining particles have become widely scattered through the atmosphere.

EXERCISE (1-2-7)

1. List the five hydrometeors.

2. List the five lithometeors.

3. Classify the specific hydrometeor or lithometeor described in each of the following statements:

a. ________ Water droplets are suspended in the air to a depth of 40 feet.

b. ________ Loose snow is blown by the wind to a height of four feet.

c. ________ Loose sand is blown by the wind and restricts visibility to three miles.

d. ________ The disk of the sun appears very red at sunrise and the visibility is five miles due to a suspension of particles in the air.

Learning Objective: From simulated observational data, indicate the entries for columns 4, 5, and 13 of MF 1-10 to include appropriate remarks for visibility, weather, and obstructions to vision in airways code.

ORDER OF ENTRY FOR WEATHER AND OBSTRUCTIONS TO VISION

Whenever weather and obstructions to vision are present at the time of the observation, you must enter the appropriate weather symbol and intensity in column 5 of MF 1-10. The correct order of entry is this:

1. TORNADO, FUNNEL CLOUD, or WATER SPOUT.
2. Thunderstorm.
3. Liquid precipitation, in order of decreasing intensity.
4. Freezing precipitation, in order of decreasing intensity.
5. Solid precipitation, in order of decreasing intensity.
6. Obstructions to vision, in order of decreasing predominance, if discernible.

Table 1-2-5 shows the weather and obstruction to vision symbols that are used in column 5. Remember, to enter obstructions to vision, you must have a prevailing visibility (column 4 entry) of less than seven miles. If the visibility is reduced to less than seven miles by obscuring phenomena not at the station, report the phenomena in remarks (column 13). As indicated in table 1-2-5, tornado, funnel cloud, and waterspout are always spelled out in full. This permits ready identification of these severe weather phenomena. If there is not enough space in column 5 for a one-line entry, use as many lines as necessary and start subsequent observations on the next line.

COLUMN 13

Significant remarks for weather and obstructions to vision provide added information for the entries in column 5. We have discussed entries and remarks for storm phenomena earlier in this lesson. In this section we will discuss other remarks.

The following guidelines apply to all column 13 remarks as well as those for weather and obstructions to vision:

1. Use accepted weather contractions whenever possible.

2. Spell out remarks that may be misinterpreted for other data (SW—Is this southwest or snow showers?).

3. Enter directions of phenomena, using 16-points of the compass (N, NNE, NE, etc.).

4. Enter a dash between the directions when the phenomena extends from one point to the horizon to another (NE-SE or N-NE).

5. Enter additional direction references in a clockwise direction when the phenomena exceeds a 90 degree portion of the horizon circle (NW-NE-E or N-E-SSE).

6. Enter distances to phenomena in nautical miles when known and appropriate. Enter all time references in GMT.

Table 1-2-5.—Symbols for weather and obstruction to vision and order of entry for Column 5

WEATHER			
Tornadic Activity	TORNADO WATERSPOUT FUNNEL CLOUD	Hail	A
		Ice Crystals	IC
		Ice Pellets	IP
		Ice Pellet Showers	IPW
Severe Thunderstorm	T+	Snow	S
Thunderstorm	T	Snow Grains	SG
Drizzle	L	Snow Pellets	SP
Rain	R	Snow Showers	SW
Rain Showers	RW		
Freezing Drizzle	ZL		
Freezing Rain	ZR		
OBSTRUCTIONS TO VISION			
Fog	F	Haze	H
Ground Fog	GF	Smoke	K
Ice Fog	IF	Dust	D
Blowing Snow	BS	Blowing Dust	BD
Blowing Spray	BY	Blowing Sand	BN

NOTES:

1. Combinations of these symbols are entered in the following order:

   a. TORNADO, FUNNEL CLOUD, or WATERSPOUT

   b. Thunderstorm

   c. Liquid precipitaton, in order of decreasing intensity

   d. Freezing precipitation, in order of decreasing intensity

   e. Frozen precipitation, in order of decreasing intensity

   f. Obstructions to vision, in order of decreasing predominance, if discernible

2. Obstructions to vision are reported in Column 5 only when the prevailing visibility is less than 7 miles and the obstruction to vision is occurring at the station. If the visibility is reduced to less than 7 miles by obscuring phenomena not at the station, report the phenomena in Remarks. Note that intensity symbols are not used with obstructions to vision.

Other Significant Remarks

Tabulated below are observed elements and conditions that require remarks, the guidelines for their entry, and some examples of typical entries:

OBSERVED	GUIDELINES FOR REPORTING	ENTRY
Precipitation varying in intensity during of observation.	Enter type and intensity (from column 5), OCNLY, and type and intensity to which it varied.	R– OCNLY R, SW OCNLY SW–
Shallow ground fog.	When the ground fog depth is less than six feet. Enter shallow ground fog depth in feet.	SHLW GFDEP4
Drifting snow.	When snow is drifting and does not restrict the visibility at eye level (six feet above the surface). Omit if blowing snow (BS) is reported.	DRFTG SNOW
Dust devils.	Enter dust devils followed by direction from station.	DUST DEVILS SW
Obscuring phenomena at a distance from and not at the station.	Enter type, description, and direction from station.	F BANK N-E-S
Increase in snow depth.	Average snow depth increases by one inch or more during past hour.	SNOINCR 2
Fog dissipating or increasing.	Self-explanatory	F DSIPTG or F INCRG
Smoke drifting over field.	Self-explanatory	K DRFTG OVR FLD

EXERCISE (1-2-8)

From the following simulated observational data (at observation time) what entries, if any, are made in columns 4, 5, and 13 of MF 1-10 for visibility, weather, and obstructions to vision, and remarks?

1. **There is a CB 10 miles northeast of the station and moving toward the east. A few peals of thunder are heard and occasional flashes of incloud lightning are seen to the northeast. Rain showers are falling from the CB but not at the station, and the prevailing visibility is eight miles.**

   a. **Column 4 ______________________________ .**

   b. **Column 5 ______________________________ .**

   c. **Column 13 ______________________________ .**

2. **Light snow is falling. Surface winds are picking up the snow from the surface to a height above six feet and the prevailing visibility is one mile. Visibility to the north is 3/4-mile and to the west is 1/2-mile.**

   a. **Column 4 ______________________________ .**

   b. **Column 5 ______________________________ .**

   c. **Column 13 ______________________________ .**

3. **Moderate snow and light freezing rain are falling. Fog is present and obscuring 1/10 of the sky. The prevailing visibility is 0 miles and the visibility to the northeast is 1/16 mile.**

   a. **Column 4 ______________________________ .**

   b. **Column 5 ______________________________ .**

   c. **Column 13 ______________________________ .**

4. **Dust is being picked up by high, gusty surface winds. Prevailing visibility is four miles. The control tower reports a visibility of six miles.**

   a. **Column 4 ______________________________ .**

   b. **Column 5 ______________________________ .**

   c. **Column 13 ______________________________ .**

Learning Objective: From simulated observational data, indicate the entries (on MF 1-10 modified for METAR, CNOC 3140/11) for columns 4, 5, and 13 to include appropriate remarks for visibility, weather, and obstructions to vision in METAR code.

METAR CODE

Surface observations are recorded, depending on the reporting station, on three (3) different forms. The majority of Aerographer's Mates use Federal Meteorological Form 1-10, Surface Weather Observations (MF 1-10). This form is used for shore reporting stations; CNOC 3140/7 for airways in the U.S. and CNOC 3140/11 for METAR overseas. The third form CNOC 3140/8 is used by Aerographer's Mates and Quartermasters reporting from ships. Shipboard reporting procedures will be covered in Lesson 4—Miscellaneous Observations. Up to this point most of the information has been directed towards the airways code format. Some entries for METAR code differ from airways code. The following information gives the requirements for METAR entries.

VISIBILITY

Prevailing visibility for column 4A is entered in whole and/or fractional parts of statute miles (whole and/or decimal parts of nautical miles). Column 4B is prevailing visibility in meters. Column 4C is RVR for local dissemination. Column 4D is RVR for longline dissemination.

Remarks for visibility are entered in column 13. Enter VIS followed by appropriate remark.

WEATHER AND OBSTRUCTIONS TO VISION

Column 5A for local dissemination is entered by using the letter codes in parentheses form table 1-2-6. Column 5B for longline dissemination is entered by using the numbers and letters codes from table 1-2-6. Only one code may be selected for longline dissemination. (See notes for table 1-2-6.)

Remarks for weather and obstructions to vision are entered in accordance with table 1-2-7.

Table 1-2-6.—METAR present weather (page 1)

ENTRIES ON METEOROLOGICAL FORM 1-10

B3-47

In selecting codes, see explanatory notes on the following page.				SMOKE (FU) 04FU	HAZE (HZ) 05HZ	DUST (HZ) 06HZ	BLOWING DUST OR BLOWING SAND (BLSA) 07SA	DUST DEVILS (PO) 08PO	
MIST (FG) 10BR	SHALLOW FOG (OR ICE FOG) at the station and not deeper than six feet: PATCHES (MIFG) 11MIFG	CONTINUOUS (MIFG) 12MIFG					THUNDERSTORM BUT NO PRECIPITATION (TS) or (TS+) 17TS	SQUALL (SD) 18SD	FUNNEL CLOUD, TORNADO, OR WATERSPOUT (TORNADO), ETC. 19FC
RECENT PRECIPITATION (at the station during the preceding hour but not at the time of observation)									
CONTINUOUS OR INTERMITTENT					SHOWERY				
DRIZZLE (or Snow Grains) 20REDZ	RAIN 21RERA	SNOW 22RESN	RAIN AND SNOW MIXED OR ICE PELLETS (type a) 23RERASN	FREEZING RAIN OR FREEZING DRIZZLE 24REFZRA	RAIN SHOWERS 25RESH	SHOWERS OF SNOW OR OF RAIN AND SNOW 26RESNSH	SHOWERS OF HAIL, SNOW PELLETS, or ICE PELLETS (type b) W or WO RECENT RAIN SHOWERS 27REGR		RECENT THUNDERSTORM W or WO RECENT PRECIPITATION 29RETS
DUSTSTORM OR SANDSTORM						DRIFTING SNOW		BLOWING SNOW	
LIGHT TO MODERATE			HEAVY						
during the past hour has:			during the past hour has:						
DECREASED (SA) 30SA	SHOWN NO CHANGE (SA) 31SA	BEGUN OR INCREASED (SA) 32SA	DECREASED (SA+) 33XXSA	SHOWN NO CHANGE (SA+) 34XXSA	BEGUN OR INCREASED (SA+) 35XXSA	LIGHT TO MODERATE (DRSN) 36DRSN	HEAVY (DRSN+) 37DRSN	LIGHT OR MODERATE (BLSN-) or (BLSN) 38BLSN	HEAVY (BLSN+) 39BLSN
FOG OR ICE FOG								FREEZING FOG	
		during preceding hour has:							
		BECOME THINNER		SHOWN NO CHANGE		BEGUN OR BECOME THICKER			
PATCHES not at the station and deeper than six feet (BCFG) 40BCFG	PATCHES at the station and deeper than six feet (BCFG) 41BCFG	SKY VISIBLE (FG) 42FG	SKY OBSCURED (FG) 43FG	SKY VISIBLE (FG) 44FG	SKY OBSCURED (FG) 45FG	SKY VISIBLE (FG) 46FG	SKY OBSCURED (FG) 47FG	SKY VISIBLE (FZFG) 48FZFG	SKY OBSCURED (FZFG) 49FZFG
DRIZZLE (NOT FREEZING)						FREEZING DRIZZLE		DRIZZLE AND RAIN MIXED	
LIGHT		MODERATE		HEAVY					
INTERMITTENT (DZ-) 50DZ	CONTINUOUS (DZ-) 51DZ	INTERMITTENT (DZ) 52DZ	CONTINUOUS (DZ) 53DZ	INTERMITTENT (DZ+) 54XXDZ	CONTINUOUS (DZ+) 55XXDZ	LIGHT (FZDZ-) 56FZDZ	MODERATE OR HEAVY (FZDZ) or (FZDZ+) 57XXFZDZ	LIGHT (RA-DZ-) 58RA	MODERATE OR HEAVY (RADZ-), (DZ+ RA), etc 59RA
RAIN (NOT FREEZING)						FREEZING RAIN		RAIN (OR DRIZZLE) AND SNOW MIXED	
LIGHT		MODERATE		HEAVY					
INTERMITTENT (RA-) 60RA	CONTINUOUS (RA-) 61RA	INTERMITTENT (RA) 62RA	CONTINUOUS (RA) 63RA	INTERMITTENT (RA+) 64XXRA	CONTINUOUS (RA+) 65XXRA	LIGHT (FZRA-) 66FZRA	MODERATE OR HEAVY (FZRA) or (FZRA+) 67XXFZRA	LIGHT (DZ-SN-), (RA-SN-) 68RASN	MODERATE OR HEAVY (RA-SN), (RA+SN), etc 69XXRASN
SNOW									
LIGHT		MODERATE		HEAVY					
INTERMITTENT (SN-) 70SN	CONTINUOUS (SN-) 71SN	INTERMITTENT (SN) 72SN	CONTINUOUS (SN) 73SN	INTERMITTENT (SN+) 74XXSN	CONTINUOUS (SN+) 75XXSN	ICE CRYSTALS (IC) 76IC	SNOW GRAINS (SG-), (SG), (SG+) 77SG		ICE PELLETS (type a, formerly sleet) (PE-), (PE), (PE+) 79PE
RAIN SHOWERS			RAIN AND SNOW SHOWERS MIXED		SNOW SHOWERS		SNOW PELLET OR ICE PELLET (type b, formerly small hail) SHOWERS with or without rain, or rain and snow mixed		HAIL (not associated with thunderstorm)
LIGHT (RASH-) 80RASH	MODERATE (RASH) 81XXSH	HEAVY (RASH+) 82XXSH	LIGHT (RASH-SNSH-) 83RASN	MODERATE OR HEAVY (RASH-SNSH), etc 84XXRASN	LIGHT (SNSH-) 85SNSH	MODERATE OR HEAVY (SNSH) or (SNSH+) 86XXSNSH	LIGHT (SNSH-PESH-) 87GR	MODERATE OR HEAVY (RASH-PESH), etc 88GR	WITH OTHER LIGHT PRECIP (GRSNSH-), etc 89GR
HAIL (not associated with thunderstorm)	THUNDERSTORM DURING PRECEDING HOUR but not at time of observation, with				THUNDERSTORM AT TIME OF OBSERVATION				
	RAIN AT TIME OF OBSERVATION				MODERATE		SEVERE	MODERATE OR SEVERE	SEVERE
ALONE OR WITH OTHER MODERATE OR HEAVY PRECIP (GR), (RASH+GR) etc. 90XXGR	LIGHT (RASH-), (RA-) 91RA	MODERATE OR HEAVY (RASH), (RA+), etc 92XXRA	HAIL WITH OTHER LIGHT PRECIP, OR LIGHT SNOW PELLET or ICE PELLET SHOWERS, SNOW OR RAIN AND SNOW MIXED (RASH-GR), (SNSH-), etc. 93GR	HAIL ALONE OR WITH OTHER MOD TO HVY PRECIP, OR MOD TO HVY SNOW PELLET OR ICE PELLET SHOWERS, SNOW, OR RAIN AND SNOW MIXED (GR), (SNSH), etc 94XXGR	WITH RAIN AND/OR SNOW (TSRASH-), etc 95TS	WITH HAIL, SNOW PELLET, OR ICE PELLET (type b) SHOWERS (TSGR), (TSPESH-), etc 96TSGR	WITH RAIN AND/OR SNOW (TS+SNSH), (TS+RASH+) etc 97XXTS	WITH DUSTSTORM OR SANDSTORM (TSSA), (TS+SA-), etc 98TSSA	WITH HAIL, SNOW PELLET, OR ICE PELLET (type b) SHOWERS (TS+GR), (TS+PESH), etc 99XXTSGR

209.454

Tabie 1-2-6.—METAR present weather (page 2)

1. Code Selection. In general, the highest applicable code will be selected for entry in Column 5B (longline). However, code 19FC has priority over all other codes in the table, code 17TS has priority over codes 04-49, and recent phenomena (codes 20-29) are reported only if no other code is applicable at the time of observation.

2. Codes 07, 10, 30-35, 38-39, and 41-47. Report these codes using the affect of the phenomena on horizontal visibility according to the following guide:

VISIBILITY

CODES	METERS	NAUTICAL MILES	STATUTE
41-47	0000-0900	0.0 - 0.5	0 - 1/2
33-35, 39	0000-0400	0.0 - 0.2	0 - 1/4
30-32, 38 (mod)	0500-0900	0.25 - 0.5	5/16 - 1/2
07, 10, 38 (lgt)	1000-9000	0.55 - 5.0	5/8 - 6

3. Codes 10-12 and 40-47. Fog should be classified as continuous (rather than patchy) when it covers 1/2 or more of the ground normally visible; e.g., code 12 (rather than 11), code 44 (rather than 41), etc.

4. Code 18. A squall is defined as a sudden increase in wind speed of at least 15 knots and sustained at 20 knots or more for at least 1 minute. This code is reported only if the squall occurred within 10 minutes prior to the actual time of observation and it is the highest applicable code (see note 1 above).

5. Codes 20-29, 30-35, 42-47, and 91-94. "During the past/preceding hour" refers to the 60 minute period prior to the actual time of the current observation being taken.

6. Codes 30-35 and 42-47. "Increased/becoming thicker" and "decreased/becoming thinner" conditions are primarily based on trends and changes occurring during the past hour, using the affect of the phenomenon on horizontal and/or vertical visibility as a guide. However, when conditions during the past hour were variable, the code considered most representative based on the change occurring since the last observation may be selected.

7. Codes 36-37. As a general guide, report drifting snow as "heavy" (code 37) when the surface is predominatly hidden from view; otherwise, use code 36 (light to moderate).

8. Codes 48-49. Freezing fog is defined as fog whose droplets freeze upon contact with exposed objects and form a coating of rime and/or glaze. Note that is can occur even though the air temperature is above freezing.

9. Codes 50-57, 70-75, 77, 85-86, and appropriate 90-series. Determine the intensity of drizzle or snow (occurring alone) using the affect of the phenomena on horizontal visibility according to the following guide.:

VISIBILITY

INTENSITY	METERS	NAUTICAL MILES	STATUTE MILES
Heavy	0000-0400	0.0 - 0.2	0 - 1/4
Moderate	0500-0900	0.25 - 0.5	5/16 - 1/2
Light	1000 or more	0.55 or more	5/8 or more

10. Codes 89, 90, 93, 94, 96 and 99. To report the occurrence of hail, select the code with regard to the intensity of other types of precipitation and/or the thunderstorm with which the hail is associated. If the hail occurs alone, select code "90XXGR" or "94XXGR," as appropriate.

Table 1-2-7.—METAR significant remarks (page 1)

	A When condition observed is:	B Then enter:
1.	a. Ceiling height (i.e., to include vertical visibility in a totally obscured sky)	"CIG," ceiling designator "(D)" (M, E or W) when ceiling is less than 3,000 feet, and ceiling height "hhh" in hundreds of feet above field elevation; e.g., CIGM012, CIG110.
	b. Layer amount(s) total 5/8 or more, but do not constitute a ceiling	"CIGNO" (except, do not enter for a partly obscured sky existing alone).
	c. Variable ceiling height below 3,000 feet	"CIG," ceiling designator "(D)," and average of all observed values; and "CIG" followed by extremes of variability (lowest, "V," and highest); e.g., CIGM012 CIG010V016, CIGE029 CIG026V033.
	d. Variable sky cover (during past 15 minutes) and variability affects reporting of a ceiling below 3,000 feet	Condition existing at observation time (i.e., as in "a" above or "CIGNO"), "OCNL," and "CIG(D)hhh" or "CIGNO" for previous condition resulting from variable sky cover; e.g., CIG037 OCNL CIGE018 (see Note 1).
2.	a. Wind direction varying by 60° or more during period of observation, with wind speed more than 6 knots	"WND" followed by extremes of variability separated by a "V;" e.g., WND 270V340.
	b. Magnetic wind direction (at locations disseminating observations locally and on longline by Teletype using a single tape	Using symbolic form "MAGdd" ("dd" = wind direction in tens of degrees); e.g., MAG16.
3.	a. Prevailing visibility less than 3 miles varying by one or more reportable values	"VIS" followed by extremes of variability (lowest, "V," and highest); e.g., VIS 1/4V1/2, VIS 0.7V1.0.
	b. Sector visibility of less than 3 miles differing from prevailing visibility	"VIS," sector identification, and visibillity in the sector(s); e.g., VIS N2, VIS N1.8SE0.7. Identify the observation point if it differs from that for which prevailing visibility is reported; e.g., TWR VIS N3/4.
	c. Prevailing visibility of 4 miles or less, and a different prevailing visibility is reported from a location other than the official observation site	Location from which observation was made, "VIS," and visibility value; e.g., TWR VIS 3, TWR VIS 2.5.
4.	a. Tornado, funnel cloud, or waterspout in progress	Description, time of beginning (see Note 2), distance from station (if known), direction from station, and direction of movement or "MOVMT UNK;" e.g., TORNADO NE MOV N, FUNNEL CLOUD B20 S MOVMT UNK.
	b. Tornado, funnel cloud, or waterspout having ended or disappeared	Description, time of ending or beginning and ending (see Note 2), and direction of movement; e.g., TORNADO MOVD N, FUNNEL CLOUD B16E19 NW DSIPTD.
	c. Tornado, funnel cloud, or waterspout reported by an outside source as having occurred within the past 1 hour and has not been observed at the station or previously reported by another source	Source (or "UNCONFIRMED"), description, location, direction of movement or "MOVMT UNK," and time of observation; e.g., CIVIL POLICE TORNADO 15W EDIU MOV N 1608, PILOT TORNADO 10S MOVMT UNK.
	d. Thunderstorm in progress	"TS," time of beginning (see Note 2), distance from station (if known), direction from station, and direction of movement (if known); e.g., TS OVHD MOV SE, TSB03 SW MOV NE.
	e. Thunderstorm ending	"TS," time of ending or beginning and ending (see Note 2), and direction of movement; e.g., TS MOVD SE, TSE49 MOVD E.
	f. Lightning	Frequency ("FRQ" or "OCNL"), type, and direction from station; e.g., OCNL LTGCCCG N, FRQ LTGCAIC SE-SW. Direction may be omitted if the same as TS or CB/CBMAM remark.

Table 1-2-7.—METAR significant remarks (page 2)

	A When condition observed is:	B Then enter:
	g. Hail	"GR" and time of beginning, ending, or both (see Note 2); "HLSTO" and diameter (in inches) of the largest hailstone; e.g., HLSTO 1, GRB13E14 HLSTO 1/2.
	h. Precipitation varying in intensity during the period of observation	Type and intensity (for condition at time of observation), "OCNL," and type and intensity to which it varied during the period of observation; e.g., RA- OCNL RA, SNSH OCNL SNSH+.
	i. Precipitation at a distance from (but not at) the station	Type and intensity (or "U" if unknown), and direction from station; e.g., RASHU SW, SNSH OVR MTS N.
	j. Obscuring phenomena at a distance from (but not at) the station	Description and direction from station; e.g., FG BANK N-E.
5.	a. Breaks or an area absent of clouds in a layer, below 1,000 feet, which covers at least 5/8 but less than 8/8 of the sky	"BRKS" and direction from station; e.g., BRKS N, BRKS OVR MM. Omit remark if breaks are in all quadrants.
	b. Ceiling or sky condition at a distance differing from that at the station	Description and location; e.g., CIG LWR OVR CITY, LWR CLDS W APCHG STN, CLD BASE OBSC MTS W.
	c. Cumulonimbus (for which no thunderstorm is being reported)	"CB," distance from station (if known), location, and movement (if known); e.g., CB 20S MOV NE, CB OVHD MOV E.
	d. Cumulonimbus Mamma (with or without thunder)	Same as Cumulonimbus, except use "CBMAM;" e.g., CBMAM 10W MOV SE.
	e. Towering Cumulus	"TCU," distance (if known) and direction from station; e.g., TCU NE, TCU 25SW.
	f. Standing lenticular or rotor clouds	Description and direction from station; e.g., FEW SML ACSL SW-W, LRG ROTOR CLDS OVR MTS S.
	g. Altocumulus Castellanus	"ACCAS" and direction from station; e.g., ACCAS SE.
	h. Vertical or inclined trails of precipitation that do not reach the surface	"VIRGA" and direction from station; e.g., VIRGA NW.

NOTES:

1. Examples of variable sky cover (see remark 1d):

Observed	SKY CONDITION	REMARKS
2/8SC, varying to 3/8	2ST010 2SC025	CIGNO OCNL CIGM025
3/8SC, varying to 2/8	2ST010 3SC025	CIGM025 OCNL CIGNO
2/8ST, varying to 1/8	2ST010 3SC025 1AC080	CIGE025 OCNL CIG080

2. If the initial special observation taken for the beginning and/or ending of tronadic activity, thunderstorm, or hail was not transmitted on longline Teletype, include the time of beginning (B) and/or ending (E) with the current (most recent) remark in the next S, RS, or R observation which is transmitted longline. Enter the indicator B and/or E and the appropriate time(s) immediately following the phenomena reported; e.g., TSB35 MOV E GRB37E39 HLSTO 3/4. These B and/or E times are entered for longline transmission only.

EXERCISE (1-2-9)

1. Indicate the appropriate entries in columns 4, 5, and 13 for each of the following, in METAR code.

a. Visibility: prevailing—four statute miles runway 03 visual range is 6,000 feet.

Atmospheric phenomena: light rainshowers are occurring at the station.

Col 4A ____________________
Col 4B ____________________
Col 4C ____________________
Col 4D ____________________
Col 5A ____________________
Col 5B ____________________
Col 13 ____________________

b. Visibility: prevailing—1/4 nautical mile, NE 1/2 runway 36 visual range 1,000 feet.

Atmospheric phenomena: fog (covers 10/10 sky) no change in past hour.

Col 4A ____________________
Col 4B ____________________
Col 4C ____________________
Col 4D ____________________
Col 5A ____________________
Col 5B ____________________
Col 13 ____________________

c. Visibility: prevailing three statute miles, E 2 1/2 miles.

Atmospheric phenomena: heavy rainshowers stopped two minutes ago, moved east. Fog bank three miles west of station, increasing.

Col 4A ____________________
Col 4B ____________________
Col 4C ____________________
Col 4D ____________________
Col 5A ____________________
Col 5B ____________________
Col 13 ____________________

UNIT 1—LESSON 3

PRESSURE, TEMPERATURE, AND WIND

<u>OVERVIEW</u>

Identify and classify criteria and techniques for reporting individual elements of the surface observation report.

<u>OUTLINE</u>

PRESSURE

1. DEFINITIONS
2. DETERMINING PRESSURE
3. FORMS
4. PRESSURE COMPUTATION

TEMPERATURE

1. DEFINITIONS
2. DETERMINING TEMPERATURE
3. TEMPERATURE COMPUTATION
4. FORMS
5. TEMPERATURE EFFECTS ON THE HUMAN BODY

WIND

1. DEFINITIONS
2. DETERMINING WIND
3. WIND COMPUTATION
4. FORMS

PRESSURE

Pressure is one of the most important items used in weather forecasting.

Many years ago, scientists discovered that falling atmospheric pressure is generally associated with poor, unsettled weather; conversely, periods of fair weather are usually associated with rising (high) atmospheric pressure.

As scientists continued to make progress in weather, they found that by measuring the atmospheric pressure simultaneously at various locations and plotting the pressures on a chart, they could connect stations having equal pressure values with lines called isobars. By doing this, it

allowed them to locate distinct areas of high and low pressure.

By locating these high and low pressure areas and keeping track of their movements, aerographers were able to determine their direction, movement, and speed. They were also able to apply this knowledge in forecasting their future movement.

One pressure value that is included in the aviation observation is the altimeter setting. It is of vital interest to pilots since pilots depend on it to set their altimeters and, in turn, determine the height of the aircraft. An error in this pressure value can mean disaster.

For pressure information to be of any value to the forecaster or pilot, it must be accurate in all respects. Therefore, a responsible person must be held accountable for obtaining this information.

This responsibility rests with you, the weather observer.

Learning Objective: Define and identify the techniques for reporting individual pressure elements.

DEFINITIONS

Pressure definitions are as follows:

Atmospheric pressure. The pressure exerted by the atmosphere at a given point.

Station pressure. The atmospheric pressure at the assigned station elevation (Hp).

Station elevation (Hp). The official designated height above sea level to which station pressure pertains.

Sea level pressure. A pressure value obtained by the theoretical reduction of station pressure to sea level.

Altimeter setting. That pressure value to which an aircraft altimeter scale is set so that it indicates the altitude above mean sea level of an aircraft on the ground at the location for which the value was determined.

Pressure change. The net difference between the barometric pressure at the beginning and ending of a specified interval of time, usually the 3-hour period preceding an observation.

Pressure characteristic. The pattern of the pressure change, as would have been indicated by a barograph trace, during the specified period of time, usually the 3-hour period preceding an observation.

Pressure tendency. The pressure characteristic and amount of pressure change during a specified period of time, usually the 3-hour period preceding an observation.

Pressure Altitude. The altitude, in the standard atmosphere, a given pressure will be observed. It is the indicated altitude of a pressure altimeter at an altitude setting of 29.92 inches of mercury (1013.2 millibars) and is therefore the indicated altitude above the 29.92 inches Hg (1013.2 mb) constant pressure surface.

Density altitude. The pressure altitude corrected for temperature deviations from the standard atmosphere.

Pressure falling rapidly. A fall in station pressure at the rate of 0.06 inch Hg (2.0 mb) or more per hour with a total fall of at least 0.02 inch Hg (0.7 mb) at the time of an observation.

Pressure rising rapidly. A rise in station pressure at the rate of 0.06 inch Hg (2.0 mb) or more per hour with a total rise of at least 0.02 inch Hg (0.7 mb) at the time of observation.

Field Elevation (Ha). The official designated elevation of an airfield above mean sea level. It is the elevation of the highest point on any of the runways of the airfield.

EXERCISE (1-3-1)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

Term	Definition
1. __________ Atmospheric pressure	**a. Use to indicate the altitude of an aircraft**
2. __________ Station pressure	**b. A falling station pressure at a rate of 0.06 inch or more per hour**
3. __________ Station elevation	**c. The elevation of an airfield above mean sea level**
4. __________ Sea level pressure	**d. The official designated height above sea level to which station pressure pertains**
5. __________ Altimeter setting	**e. The pressure exerted at a given point**
6. __________ Pressure altitude	**f. The altitude, in the standard atmosphere, a given pressure is observed**
7. __________ Density altitude	**g. The pressure altitude corrected for temperature deviations**
8. __________ Pressure falling rapidly	**h. The pressure at the assigned station elevation**
9. __________ Pressure rising rapidly	**i. A pressure value obtained by a theoretical reduction**
10. __________ Field elevation	**j. A rising station pressure at a rate of 0.06 inch or more per hour**

DETERMINING PRESSURES

All atmospheric pressure measurements are made on the basis of instrumental evaluation. They vary according to local requirements and the type of equipment provided for obtaining pressure data. Each station with surface observing responsibilities must establish a barometry program. Instructions on this program can be found in *Federal Meteorological Handbook, Surface Observations (FMH-1B).*

209.394

Figure 1-3-1.—AN/GMQ-29( ).

Automatic Weather Station (AN/GMQ-29)

If your station has an AN/GMQ-29( ) installed (figure 1-3-1), all that is required to obtain the pressure reading is to observe the digital readings on the display module of the unit. The pressure readings are derived from the BAROMETRIC PRESSURE SENSOR ML-642/GMQ-29, which responds to absolute pressure by means of a pressure-sensitive capacitor for an associated pressure range of 800.0 to 1100.0 millibars.

Precision Aneroid Barometer (ML-448/UM)

The Precision Aneroid Barometer (ML-448/UM) is used aboard ship and at land stations.

Of precision design and manufacture, the precision aneroid barometer is constructed to accurately indicate atmospheric pressure in millibars or inches of mercury. (See figure 1-3-2.)

The pressure element of the precision aneroid is a Sylphon cell which consists of a bellows-shaped metal cell having an internal spring to provide pressure calibration. This element is sensitive to minute variations in atmospheric pressure. The instrument has a range from 910 to 1060 mb and it is accurate to 0.67 mb. Outside normal sea-level pressure range it is still accurate to within 1.0 mb.

To properly obtain a correct reading from the aneroid barometer you should follow the next three steps:

1. Reduce the effect of friction by tapping the face of the instrument lightly with your finger.

2. Read the scale at the pointer straight on (not left or right) to avoid the angle of parallax which causes high or low reading. You should read to the nearest 0.005 inch or 0.1 millibar, estimating any values that fall between these graduations.

3. Apply all posted corrections to the instrument that have been predetermined from instructions in FMH-1B.

Marine Barograph

The purpose of the marine barograph is to register and record the atmospheric or barometric pressure. Because of the magnified scale, high sensitivity, and accurate temperature compensation, it is often referred to as a microbarograph. The instrument is designed to maintain its precision through the varied and exacting conditions encountered in marine use. Its record is neither interrupted nor rendered inaccurate by pitch, roll, or vibration of the ship. An adjustable, grease-filled damping cylinder provides a means of preventing rise and fall of the ship from causing a corresponding wavy trace on this chart. The unit, as

209.93

Figure 1-3-2.—Precision aneroid barometer (ML-448/UM).

seen in figure 1-3-3, is quite portable and can record pressure either in its immediate vicinity or at some remote external point while located within a pressurized cabin system. This barograph has a total usable range of 170 mb (915 to 1085 mb) over which it has been calibrated and temperature-compensated.

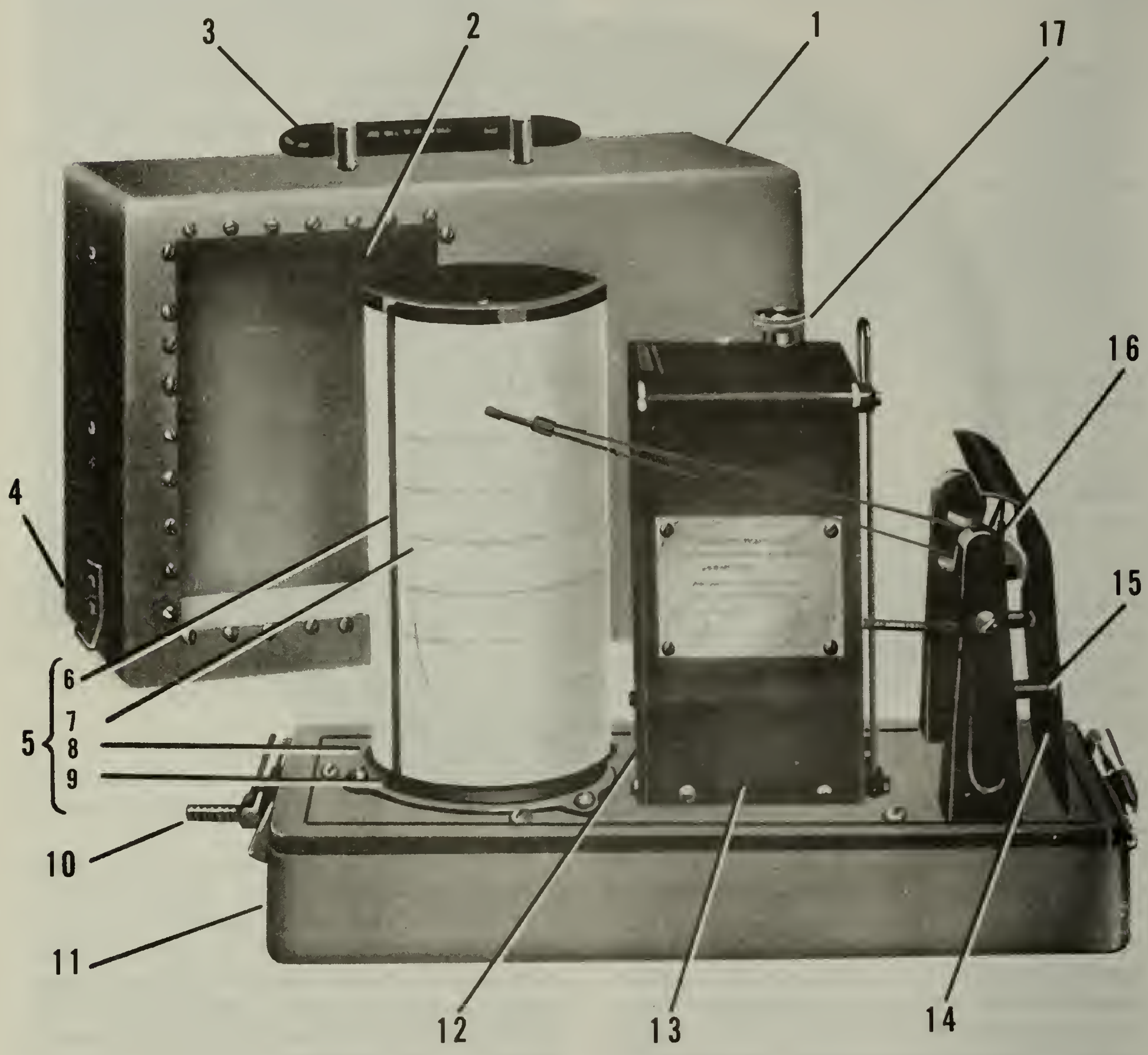
FORMS

Several types of forms are commonly used in the recording of Surface Weather Observations. For up-to-date information on filling out these forms, refer to FMH-1B for CNOC 3140/7, MF1-10, *Land Surface Weather Observations* (abridged for Naval Weather Use), and Naval Oceanography Command Instruction (NAVOCEANCOMINST) 3144.1( ) for CNOC 3140/8, *Ship's Surface Weather Observations.*

In this section only pressure entries are covered.

CNOC 3140.7 Entries

Although the following description of pressure element entries on 3140/7 is correct, it is brief. The Aerographer's Mate should refer to the FMH-1B for a more complete and detailed description of the proper procedures.



1. Case.
2. Plastic sheet.
3. Handle.
4. Latch.
5. Chart drive assembly.
6. Chart clip.
7. Chart.
8. Chart cylinder.
9. Chart drive mechanism.
10. Hose connector.
11. Base.
12. Element assembly.
13. Element cover.
14. Mechanism shield.
15. Spacer.
16. Pen shaft assembly.
17. Adjustment knob.

209.94

Figure 1-3-3.—Marine barograph.

SEA-LEVEL PRESSURE (Column 6).—Sea-level pressure is entered in tens, units, and tenths of millibars. If the pressure is estimated, prefix the value with an "E". To obtain the sea level pressure value, take the station pressure (column 17) and reduce this value to sea level by use of a computer, constant, or table. Enter an "M" for a missing sea level pressure.

ALTIMETER SETTING (Column 12).—The altimeter setting is entered in units, tenths, and hundredths of an inch, omitting the decimal point. An altimeter setting of 29.98 inches is logged as 998. Altimeter settings determined from pressure instruments of doubtful accuracy or which are not routinely compared with a mercurial barometer are prefixed with an "E". Compute the altimeter setting value from the station pressure (column 17) by using a computer, constant, or table. Enter an "M" for a missing altimeter setting.

MANDATORY REMARKS (Column 13).—These remarks include the pressure tendency at 3-hour intervals. Other data includes pressure that is rapidly rising or falling, barogram "V", unsteady pressure, and pressure jumps.

STATION PRESSURE (Column 17).—Enter station pressure to the nearest 0.005 inch.

CNOC 3140/8 Entries

Here again the descriptions of pressure are brief. The Aerographer's Mate should refer to the NAVOCEANCOMINST 3144.1( ) for a complete and detailed description of the proper procedures for the CNOC 3140/8 entries (shown in Appendix VI).

SEA LEVEL PRESSURE (Column 6).—Enter sea level pressure in the same manner as that for 3140.7.

Aboard Navy ships, sea level pressure is obtained by adding a constant pressure-reduction factor to the station pressure as entered in column 17. This constant is the product obtained by multiplying the height (in feet) of the precision aneroid barometer above the loadline by either 0.001 inch or 0.037 mb, depending on the markings of the barometer.

ALTIMETER SETTING (Column 12).—Enter the altimeter setting in the same manner as on 3140.7. Ordinarily, altimeter settings are computed and entered only on naval vessels from which aircraft are operated.

Shipboard altimeter settings are computed by converting sea level pressure to inches. When estimated, prefix the setting with an "E". Some ships may have altimeter setting indicators which are direct-reading instruments requiring only instrument error corrections.

REMARKS (Column 13).—Enter appropriate remarks in the same manner as in column 13 of 3140/7. The major exception to this is that additive data referred to in sections covering land station observations are not entered aboard ships.

STATION PRESSURE (Column 12).—Station pressure aboard ship is determined from precision aneroid barometers. It is entered in the same manner as in column 17 on 3140/7.

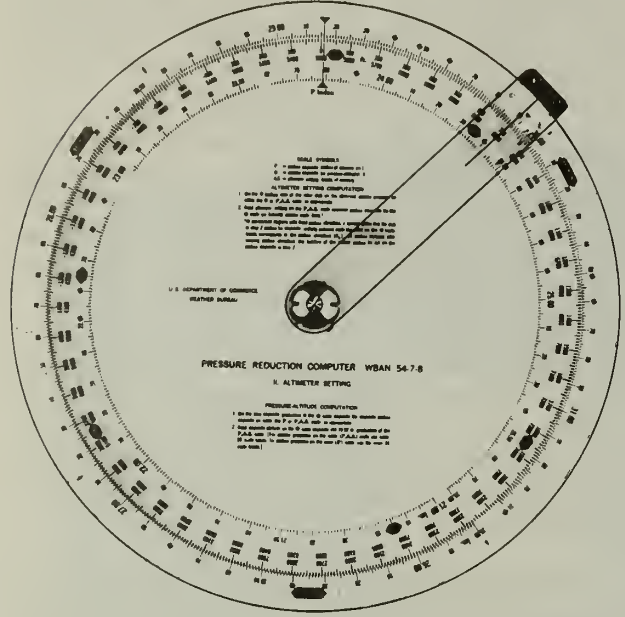
When rolling of the ship causes the indicator on the aneroid barometer to oscillate, the main position is used for the station pressure.

PRESSURE COMPUTATION

Sea Level Pressure

Sea level pressure is obtained by several methods, depending on the elevation of the station. It is computed, recorded, and transmitted for each hourly, 3-hourly, and 6-hourly observation. Stations with low elevations above sea level (or below sea level) use a constant reduction factor. Stations for which a constant reduction factor has not been established use Meteorological Pressure Reduction Computer CP-402/UM.

CONSTANT ADDITIVE CORRECTION.—Most naval shore activities and all ships can reduce station pressure to sea level pressure by a constant additive correction. This constant additive correction is a permanent value to be added (algebraically) to the station pressure. Each station authorized to use the constant additive correction has been assigned this value



209.379
Figure 1-3-4.—Pressure reduction computer (CP-402/UM).

by Naval Oceanography Command Detachment (NOCD), Asheville, N.C. For instance, NOCD, Adak, Alaska, would add +0.017 to the station pressure in order to obtain sea level pressure.

REDUCTION BY COMPUTER.—Shore activities not authorized to use the constant additive correction, use Meteorological Pressure Reduction Computer CP-402/UM. (Refer to figure 1-3-4.)

The Pressure Reduction Computer is primarily used for computing sea level pressure and altimeter settings. It may also be used to compute pressure altitude. Both sides of the computer are used. The sea level pressure side of the computer has scales in millibars and in inches of mercury printed on the base plate and an "r" factor scale printed on the plastic rotor disk. The altimeter setting/pressure altitude side has a scale in inches of mercury on the base plate and a height scale in feet printed on the plastic rotor disk. Instructions for the operation of it are printed on the computer.

To obtain "r" tables, send a request to the NOCD, Asheville, N.C.

Pressure Tendency

The barometric pressure tendency comprises the net change within a specified time and the characteristic of the change during that time. Pressure tendencies are determined at stations equipped with a microbarograph. Stations not equipped with a barograph will use the trend of the station pressure column to determine the pressure tendency. The pressure tendency is determined for the full 3-hour period ending at the actual time of the observation.

Classify the characteristic of the barograph trace for the 3-hour period, using the code numbers prescribed in FMH-1B table, corresponding to the same general pattern. When the tendency of the observed trace is incompatible with the sign of the net change, select the tendency that is most nearly representative and still compatible with this sign.

Altimeter Setting

The aerographer should not underrate the importance of the altimeter. Particularly important is the altimeter setting which ensures that the pilot always has a correct reading available to him. Many aircraft accidents may have been caused by a faulty altimeter setting.

Altimeter settings are computed for all observations with the exception of a single element special. They are recomputed when necessary to meet local requirements or upon request.

Careless and hasty altimeter settings contribute to potential accidents of aircraft; therefore, use extreme care in computing them—as you would in all phases of weather observations.

Most stations have tables of altimeter settings already prepared. Some stations may have tables that you enter with the station pressure (rounded off) and emerge with the altimeter setting. Other stations may have tables which require you to make the 0.01 correction to station pressure and then enter the table. Refer to FMH-1B for the use of altimeter-setting tables.

Density Altitude Computer CP-718/UM

Helicopters have their greatest lift and attain highest speeds in air of high density. Thus, pilots

of these craft prefer to fly under conditions of low temperature and high pressure, since this is when the air is most dense. Pilots of jet aircraft have a great interest in the density of the air because air density not only affects speed, rate of climb, and fuel consumption, but also plays an important role in determining the length of runway necessary for takeoff.

The Density Altitude Computer CP-718/UM (figure 1-3-5) consists of two plastic or metal disks and one cursor. The bottom disk contains the temperature expressed in Celsius and Fahrenheit, while the top disk contains the pressure density, moisture correction, and dry bulb temperature scales. On the cursor is found a wet bulb temperature scale.

The computer was primarily designed to compute atmospheric density. It may, however, also be used to interconvert thermometric scales, pressure units, density ratio, vapor pressure, specific humidity, etc. The operating instructions are printed on the back of the computer.

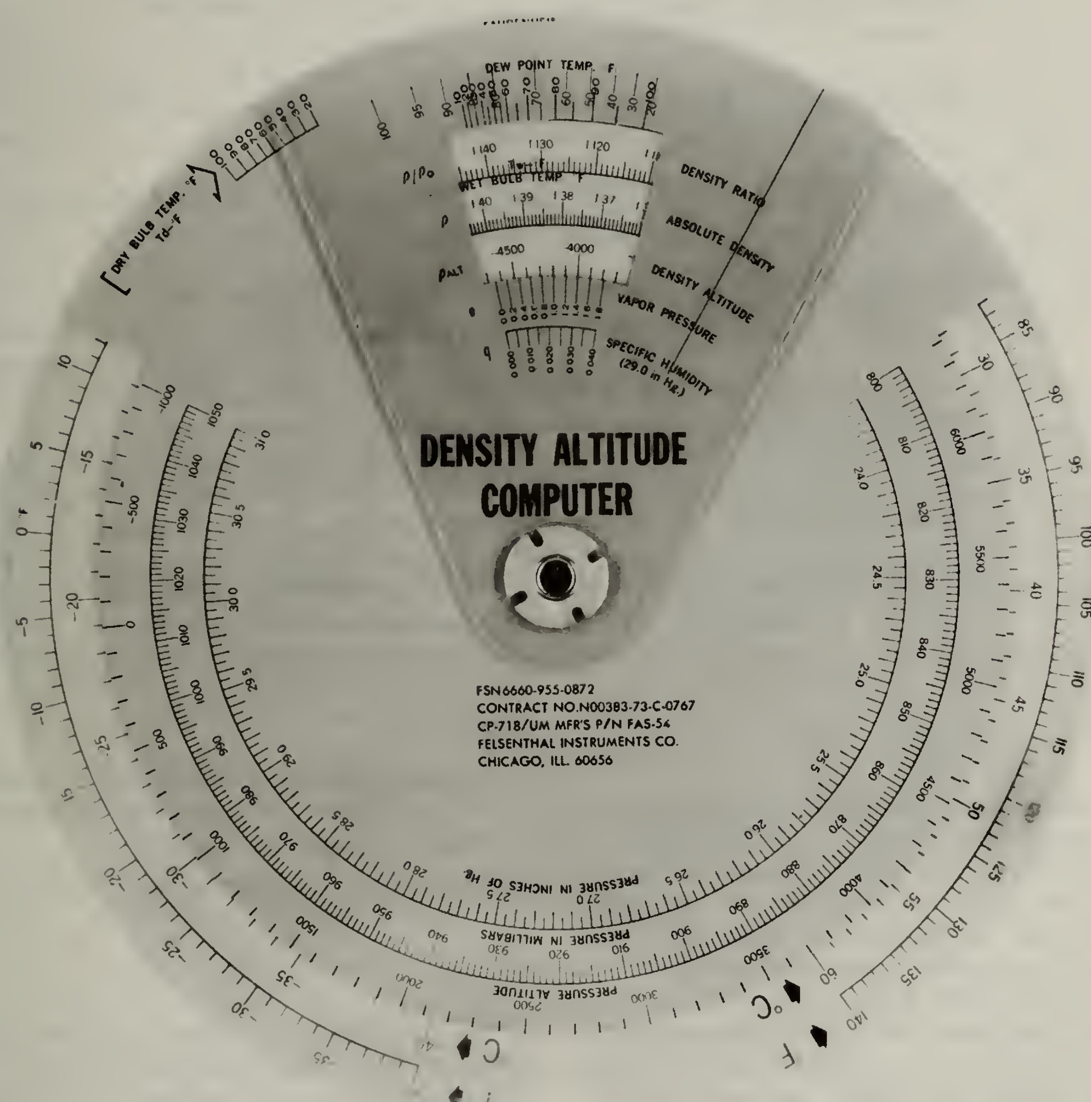


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Figure 1-3-5.—Density altitude computer (CP-718/UM).

EXERCISE (1-3-2)

Fill in the missing words in statements 1 through 9.

1. **The pressure readings taken from an AN/GMQ-29 are obtained by observing the digital readings on the ______________.**

2. **The precision aneroid barometer is constructed to accurately indicate atmosphere pressure in ______________ or inches of mercury.**

3. **When reading the precision aneroid barometer, you must tap the face lightly with your finger in order to ______________ the effect of friction.**

4. **The purpose of the marine barograph is to ______________ and ______________ the atmospheric pressure.**

5. **Surface weather observation form CNOC 3140/7 is used for ______________ observations.**

6. **Surface weather observation form CNOC 3140/8 is used for ______________ observations.**

7. **When recording sea level pressure (Col. 6) on CNOC 3140/7, the pressure is entered in tens, units, and tenths of ______________.**

8. **When recording altimeter setting (Col. 12) on CNOC 3140/7, the setting is entered in units, tenths, and hundredths of an ______________.**

9. **When recording station pressure (Col. 17) on CNOC 3140/7, the pressure is entered to the nearest ______________ inch.**

TEMPERATURE

Temperature often is defined as the degree of sensible heat of a substance. The temperature of one body is said to be higher (hotter) or lower (colder) than another according to whether it imparts heat or receives it when the two are brought together. Since this criterion of temperature based on heat transfer is relative, scientists often have to use another temperature scale based on a point of absolute zero. In this scale, temperature is regarded as a measure of molecular motion, and its intensity is measured from an absolute zero point at which all molecular motion is considered as ceasing to exist.

Learning Objective: Define and identify the techniques for reporting individual temperature elements.

DEFINITIONS

Air temperature. A measure of the average kinetic energy of the molecules of the air. It is commonly measured according to the Fahrenheit and Celsius scales.

Dewpoint temperature. The temperature to which a given parcel of air must be cooled at

constant pressure and constant water vapor content in order for saturation to occur.

Dry-bulb temperature. The ambient temperature registered by the dry-bulb thermometer of a psychrometer. However, it is identical with the temperature of the air and may be used in that sense.

Wet-bulb temperature. The temperature an air parcel would have if cooled adiabatically to saturation at constant pressure by evaporation of water into it. It differs from the dry-bulb temperature by an amount dependent on the moisture content of the air and, therefore, is generally the same as or lower than the dry-bulb temperature.

Wet-bulb depression. The difference between the wet-bulb and dry-bulb temperatures.

Relative humidity. The ratio, expressed as a percentage, of the actual vapor pressure of the air to the saturation vapor pressure.

Psychrometer. An instrument used for measuring the water vapor content of the air. It consists of two ordinary glass thermometers. The bulb of the wet-bulb thermometer is covered with a clean muslin wick which is saturated with water prior to an observation. When the bulbs are properly ventilated, they indicate the wet- and dry-bulb temperatures of the atmosphere.

Psychrometric calculator. A circular slide rule used to compute dew point and relative humidity from known values of wet- and dry-bulb temperatures and the normal station atmospheric pressure. Instructions for the use of this calculator are printed on it.

Psychrometric tables. Tables prepared from a psychrometric formula and used to obtain dew point and relative humidity from known values of wet- and dry-bulb temperature.

Sling psychrometer. A device for determining psychrometric data consisting of two matched thermometers mounted on a common back. The wet-bulb is covered with a muslin wick which is saturated with water prior to an observation. Ventilation is achieved by whirling the thermometers with a handle and a swivel link until the maximum wet-bulb depression has been obtained.

Electric psychrometer. The electric psychrometer ML-450A/UM is a hand-held portable instrument which serves the same purpose as the rotor and sling psychrometers. Three "D" size batteries furnish power to a self-contained ventilation fan which aspirates the thermometers. The instrument also contains a lamp for nighttime readings.

EXERCISE (1-3-3)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

1. ________ Air temperature
2. ________ Dew point temperature
3. ________ Dry-bulb temperature
4. ________ Wet-bulb temperature
5. ________ Wet-bulb depression
6. ________ Relative humidity
7. ________ Psychrometer
8. ________ Psychrometric calculator
9. ________ Psychrometric tables
10. ________ Sling psychrometer
11. ________ Electric psychrometer

a. The temperature to which a given parcel of air must be cooled for saturation to occur

b. Tables used to obtain dew point and relative humidity

c. The ratio, expressed as a percentage, of the actual vapor pressure of the air to the saturation vapor pressure

d. A circular slide rule used to compute dew point and relative humidity

e. An electric hand-held portable instrument used to obtain maximum wet-bulb depression

f. The ambient temperature

g. The temperature of an air parcel cooled adiabatically to saturation

h. An instrument used for measuring the water vapor content of the air

i. A hand-held instrument used to whirl thermometers through the air for obtaining the maximum wet-bulb depression

j. A measure of the average kinetic energy of the molecules of the air

k. The difference between the wet-bulb and dry-bulb temperatures

DETERMINING TEMPERATURE

Use the first available operative system from the following list for obtaining temperature and/or psychrometric data:

1. Automatic weather stations

2. Psychrometer

3. Mercury or alcohol-in-glass extreme thermometers

AN/GMQ-29

The AN/GMQ-29 display unit (figure 1-3-6) gives (in digital readouts) data on temperature, dew point, maximum temperature, and minimum temperature. All temperatures are displayed in degrees Fahrenheit.

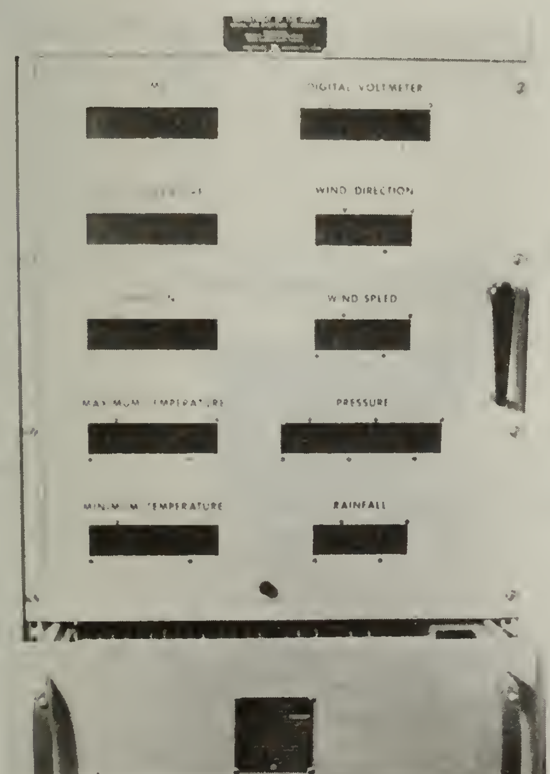

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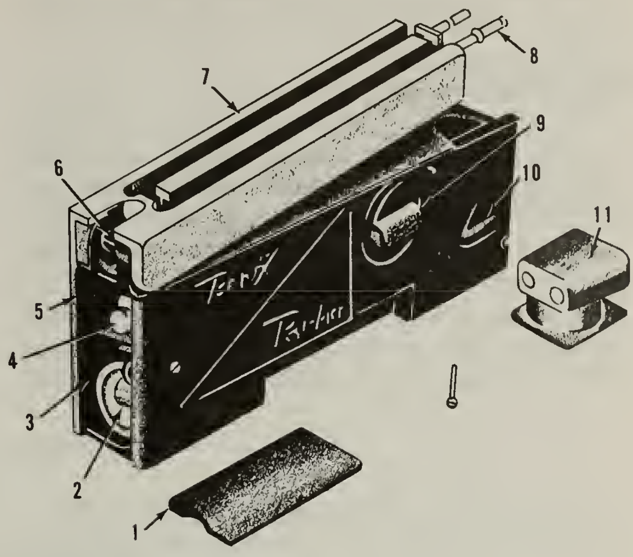
Figure 1-3-6.—AN/GMQ-29( ).



1. Sliding door.
2. Spring contact.
3. Battery compartment.
4. Water bottle.
5. Bottle compartment.
6. Hinge pin.
7. Thermometer holder.
8. Wet-bulb wick.
9. Knob.
10. Exhaust ports.
11. Sliding air intake.

209.116

Figure 1-3-7.—Hand electric psychrometer (ML-450A/UM).

Electric Psychrometer (ML-450A/UM)

The electric psychrometer (figure 1-3-7) is a hand-held portable instrument used to obtain free air temperature (dry-bulb and wet-bulb temperatures). Three "D" size batteries furnish power to a self-contained ventilation fan which blows air on the two thermometers. These thermometers have a range from +10°F to +110°F. The instrument also contains a lamp for nighttime readings. The wet bulb is covered with a muslin wick which is saturated with water prior to ventilation.

Although the psychrometer is constructed primarily of noncorrodible materials, prolonged exposure to weathering, salt air, stack gases, and other corrosive elements shortens the useful life

of the instrument. The instrument should therefore be sheltered when not in actual use.

Sling Psychrometer

Like the electric psychrometer, the sling psychrometer is used for determining the dry-bulb and wet-bulb temperatures. Ventilation is achieved by whirling the thermometers with a handle and a swivel link (figure 1-3-8) until the maximum wet-bulb depression has been obtained.

When not in use, the sling psychrometer should be hung on a suitable hook. Handle the sling psychrometer carefully at all times. The thermometers are easily broken through careless handling, dropping, or striking some object while being whirled.

Standard Thermometers

Thermometers are classified according to their operating principles and their purpose. In this section only the liquid-in-glass thermometers are discussed. (Refer to figure 1-3-9.)

Liquid-in-glass thermometers are designed on the principle of differential expansion. The fluid

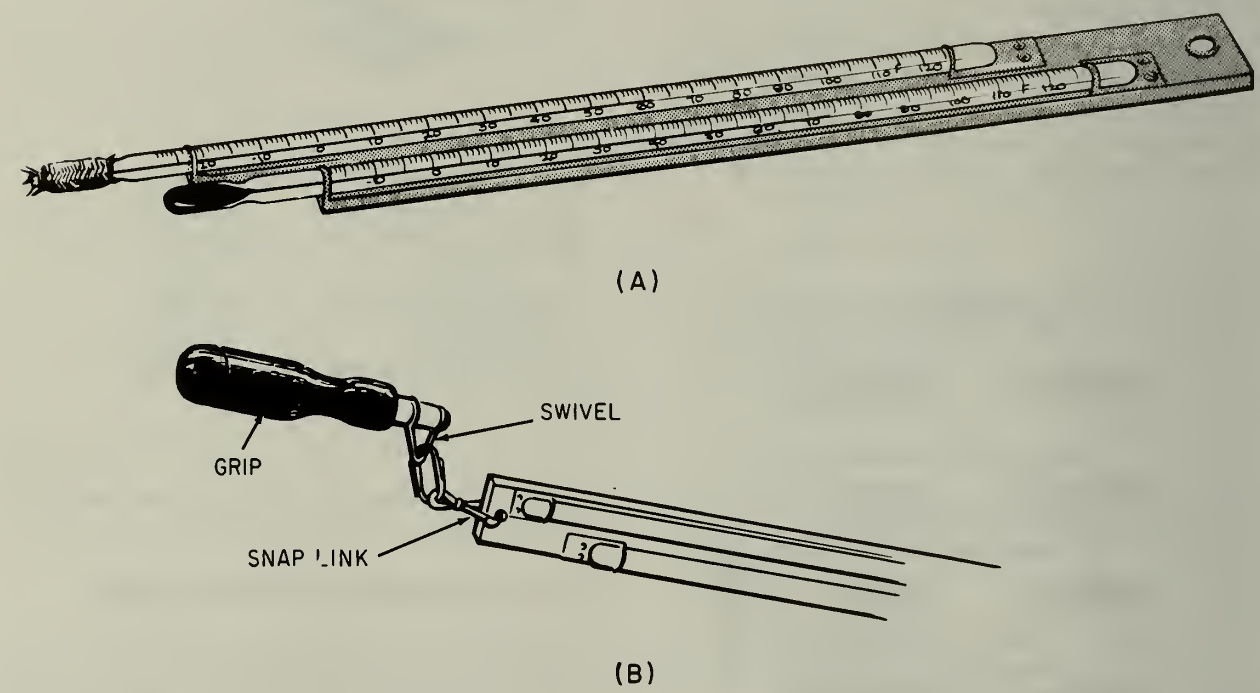


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Figure 1-3-8.—(A) Standard psychrometer; (B) with sling attached.

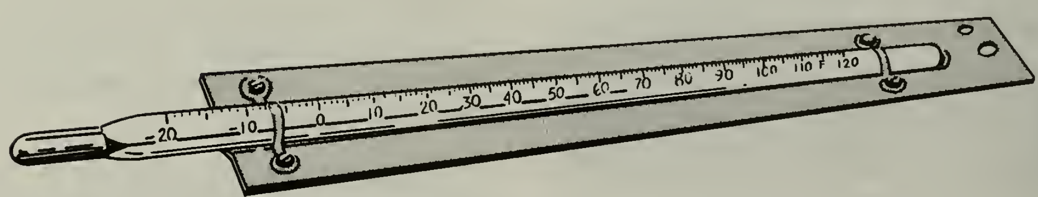

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Figure 1-3-9.—Standard air thermometer.

used in the thermometer expands and contracts at a different rate than the glass tube it is contained in. By etching an appropriate scale on the tube we can measure this difference in expansion and thereby determine the change in temperature.

The standard air thermometer which you are more than likely familiar with is the one placed inside or outside of the house to see how cold or warm the temperature was during the day or how cool the air conditioner is keeping the house. There are many common uses for this thermometer which is usually filled with either mercury or alcohol, depending on its intended use. These two fluids are used because they have a much greater coefficient of expansion for each degree of change in temperature than glass has.

The range of the standard air thermometer used by the aerographer is from −20°F to +120°F.

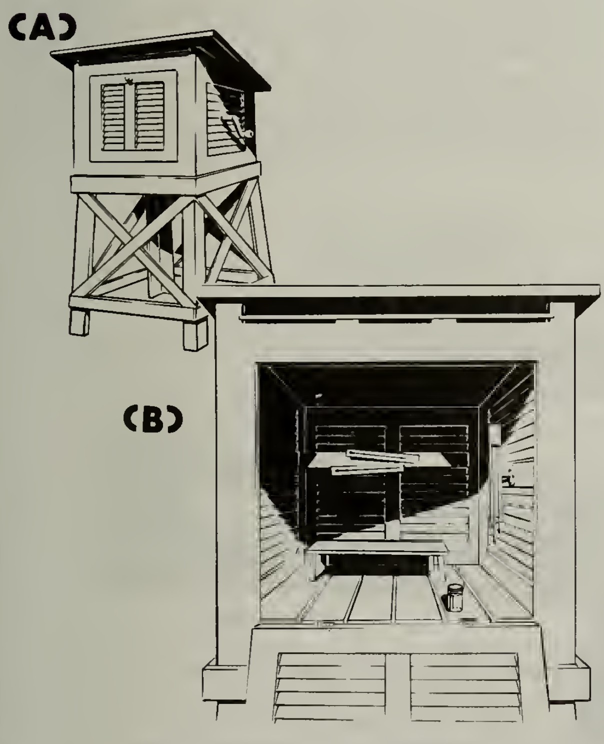
Instrument Shelter (Thermoscreen)

With the increased used of automatic weather stations, such as the AN/GMQ-29( ) that have self-contained shelters for their sensing elements, the wooden-type shelters are becoming a thing of the past. However, it is the opinion of this author that this shelter should be maintained as a backup to the AN/GMQ-29 (figure 1-3-10).

These instrument shelters are used to house several meteorological instruments including the psychrometer and the maximum and minimum thermometers.

Rotor

The rotor psychrometer shown in figure 1-3-11 is a psychrometer element secured to a handcrank-operated shaft. The rotor is designed for wall



(A) Construction of support.
(B) Instrument arrangement inside the shelter.

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Figure 1-3-10.—Standard instrument shelter.

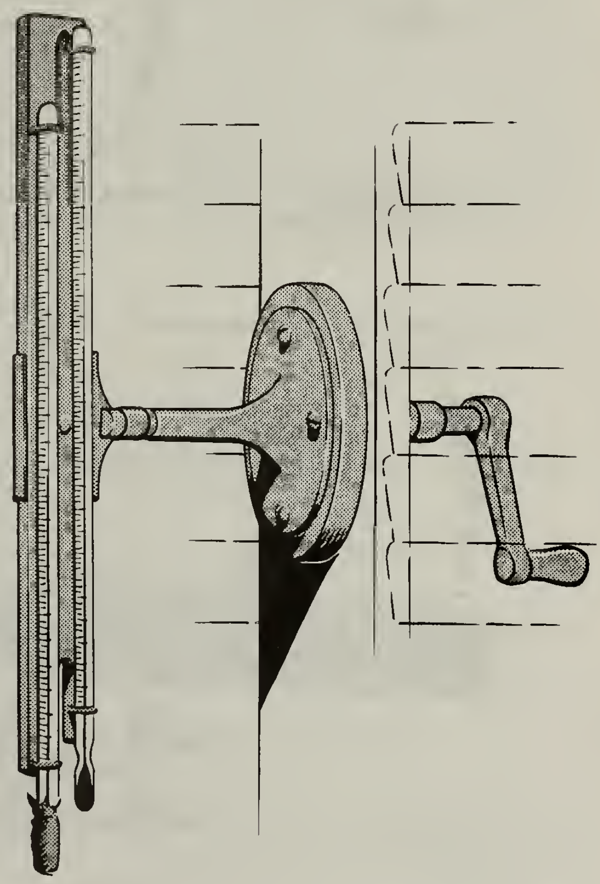

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Figure 1-3-11.—Rotor psychrometer.

mounting and permits a permanent installation in the right side wall of the instrument shelter. The same procedure is followed in obtaining a correct reading of the rotor-mounted psychrometer as was given for the sling psychrometer except that the instrument is left in the instrument shelter.

Maximum Thermometer

The maximum thermometer, as seen in figure 1-3-12(A), is a mercury thermometer. It is made so that the highest temperature reached over a period of time is indicated. The range of

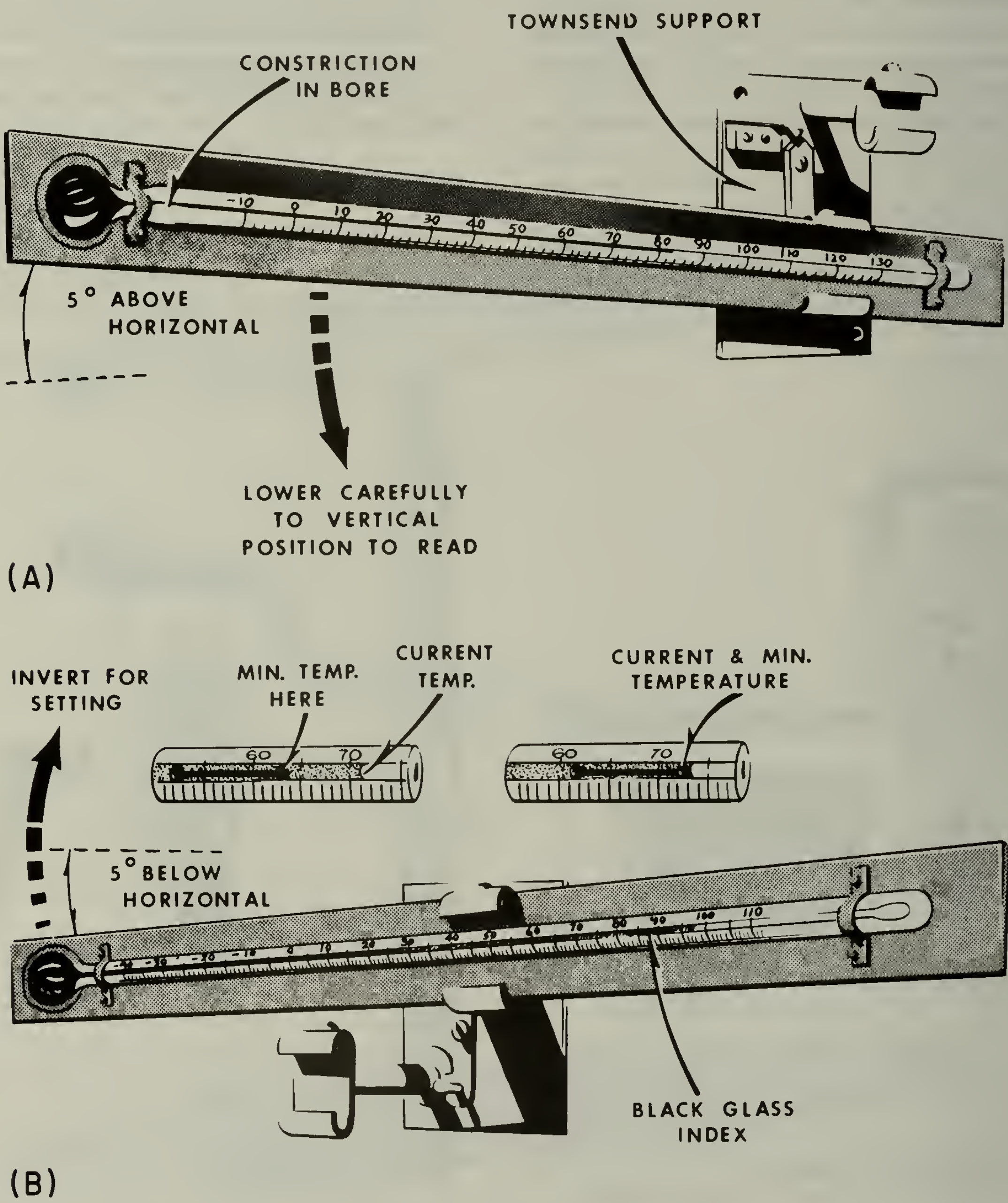

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Figure 1-3-12.—(A) Maximum thermometer; (B) Minimum thermometer.

this thermometer is from −10°F to +130°F. It resembles the standard air thermometer in markings and general dimensions, except for a round bulb. It differs in the construction of the bore in that there is a constriction in the bore, closely resembling a fever thermometer. With rising temperature, mercury is forced past the constriction by pressure of the expanding mercury in the bulb and tube. With falling temperature no such force exists. The bore constriction is small enough to prevent the normal return flow of the mercury under the force of gravity; in addition, the thermometer is mounted in its operating position so that the mercury in the column slopes away from the constriction. Expansion and contraction of the mercury in the bore above the constriction is so slight as to be negligible for meteorological measurements. Thus, the thermometer indicates the highest temperature which has been reached.

Minimum Thermometer

The minimum thermometer, as seen in figure 1-3-12(B), is an alcohol-in-glass thermometer with a range from −40°F to +110°F. It is similar to the standard air thermometer, except that it has a round bulb and a much larger, uniform bore. In construction, the upper part of the bore is filled with air under pressure, which tends to prevent the evaporation of the alcohol. Evaporation would cause the thermometer to give erroneous readings.

The most unique feature of the minimum thermometer is the index. The index is a dumbbell-shaped piece of black glass, approximately as long as 13-degree divisions of the thermometer scale. Since the index is made in this particular manner, it provides a relatively large surface of contact with the meniscus, or top of the alcohol column.

The operation of the index makes possible the minimum temperature reading. In its operating position, this thermometer always rests on the Townsend support with the bulb to the left and in a 5 degrees below horizontal position. As the temperature increases, the alcohol readily flows past the index without moving it. With a decrease in temperature, the retreating alcohol column flows past the index until the top of the column touches the upper, or right-hand, end of the index. As the alcohol retreats farther with a decrease in temperature, surface tension causes the index to be carried along with the top of the column. When the temperature increases again, the index is left undisturbed at its lowest point of displacement. The right-hand edge of the index indicates the lowest temperature reached.

EXERCISE (1-3-4)

For items 1 through 6, complete the following statements.

1. **The AN/GMQ-29 display unit gives the digital readout data on temperature, dew point, maximum temperature, and minimum temperature in degrees__________.**
2. **The hand-held electric psychrometer ML-450A/UM is a portable instrument used to obtain__________temperature and the__________temperature.**
3. **The sling psychrometer consists of two matching thermometers mounted on a common back. The wet bulb is covered with a__________which is saturated with water prior to an observation.**
4. **The range of the standard air thermometer used by the Aerographer is from__________ to__________.**
5. **The maximum thermometer is made so that it indicates the__________temperature reached over a period of time.**
6. **The minimum thermometer is made so that it indicates the__________temperature reached over a period of time.**

TEMPERATURE COMPUTATION

For aircraft operations, temperature data is required in reference to the airfield runways. Normally, temperature measurements may be taken at another location on the airfield and still be representative of the temperature over the runway. Dew point and relative humidity are calculated with respect to water at all temperatures. Temperature data are required with respect to the Fahrenheit scale in Airways observations and the Celsuis scale in METAR observations. The accuracy of an individual temperature is dependent upon its use, as stated below.

The several types of psychrometers have as their basic construction two thermometers secured as a unit to a metal back or supporting device. They may be hand-held (sling-type and electric) or rotor-mounted instruments.

The primary objective is to obtain the temperature readings of the dry-bulb and the wet-bulb thermometers, and then calculate the difference between the two readings. The difference is called the depression of the wet bulb, which is used to find relative humidity, dew point, and vapor pressure. Observations are interpreted by consulting appropriate psychrometric tables or computers.

Reading the Air Thermometer

Accuracy is the first essential in making a temperature observation. The following precautions should be observed:

- Thermometer exposure must be such as to ensure that the temperature reading is representative of the element to be observed.

- Avoid obvious scale errors in reading. Errors of five or ten degrees are more common than one- or two-degree errors in reading the scale.

- Read the thermometer quickly and always compare this reading with the last reading or other thermometers in the thermoscreen.

- Stand directly in front of the thermometer when reading it; be very careful to keep the eye on an exact level with the top of the fluid column in the bore with the line of sight at right angles to the thermometer stem.

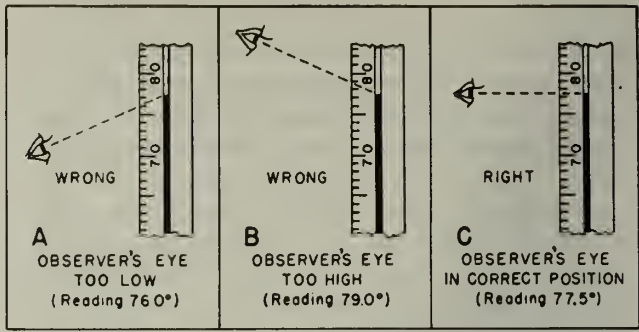

Figure 1-3-13.—Error of parallax.

Figure 1-3-13 shows possible scale errors in reading due to the error of parallax when the eye is not at the correct level. In figure (A) the eye is too low and the temperature is read too low; at (B) the eye is too high and the temperature is read too high; at (C) the eye is in the correct position and the scale reading is correctly aligned with the column.

AN/GMQ-29

When the AN/GMQ-29( ) is used to obtain psychrometric values, the dry-bulb and dew-point temperatures are read to the nearest whole degree directly from the digital windows.

Electric Psychrometer

Procedures for operating the electric psychrometer vary from those outlined in FMH-1B for psychrometers.

- Place the instrument on a flat surface with the graduations of the thermometer facing upward and the air intake positioned into the wind and to the left of the operator, or

- Grasp the instrument in the left hand with the fingers fitting the curved portion of the case, the graduations of the thermometers facing

the operator, and the air intake pointing to the left and into the wind.

CAUTION: In either position, the air intake and both exhaust ports must be entirely free of obstructions and far enough away from the operator's body or any other source that may cause an increase/decrease in humidity or temperature which could give a false reading.

Turn the switch knob clockwise to start aspiration. If thermometer illumination is desired, continue turning the knob clockwise until sufficient light intensity is obtained.

When the wet-bulb temperature stabilizes at a minimum value, note the readings of both thermometers and turn off the switch by turning the knob counterclockwise.

Expose the psychrometer to the free air for at least 5 minutes before using it for readings.

Exposure of this instrument is dependent on the outside air temperature. If it is 50°F or above, expose the psychrometer to ambient air conditions without the ventilating fan running. When the outside air temperature is below 50°F, expose the psychrometer to ambient air with the ventilating fan running.

Thoroughly saturate the wet-bulb wick with pure water, taking every precaution to prevent water from contacting either the thermometer tube or the dry bulb. Any moisture which may have contacted the dry bulb must be removed.

Sling Psychrometer

First you must select a shady area with no obstructions within 3 to 4 feet and face the sling thermometer into the wind. Hold the instrument to the front at waist height while slinging it. Keep the instrument in the shade of the body as much as practical, but not so close that body heat can affect the readings.

OPERATION OF THE PSYCHROMETER.—When possible, a psychrometer that is used regularly should be stored outside in a shaded box with good ventilation, away from spray and precipitation. If such a location is not available, store the psychrometer in the observer's office in a clean, dry place that is not exposed to extreme temperature changes. If the psychrometer is kept inside between observations, it will require longer ventilation outside to let the thermometers adjust. The greater the temperature difference between inside and outside, the longer it will take to stabilize the thermometers.

1. The muslin wick of the wet bulb should be checked for cleanliness before each observation. If salt, oil, grease and/or dirt get on the wick it must be changed before the observation. In any event, change the wick weekly.

2. The water used to moisten the wick on the wet bulb should be the purest available. If the water is not clean the wick becomes stiff and the bulb encrusted. Change the water periodically to ensure its purity.

3. To ventilate the psychrometer, the minimum speed of air passing over the bulbs should be 15 feet per second. This is approximately two revolutions per second of the sling psychrometer.

4. Read the dry bulb and wet bulb to the nearest one-tenth (0.1) degree.

PREPARATION OF WET-BULB TEMPERATURE.—Moisten the wick of the wet bulb just before each observation using the following instructions.

Temperature Above Freezing (Normal Conditions).—Moisten the wick of the wet bulb just prior to ventilating the psychrometer when the dry-bulb temperature is warmer than 37°F (3°C) even if the humidity is high or the wick already appears wet. If the wet-bulb temperature is expected to be 32°F (0°C) or colder, also moisten the wick several minutes before ventilation so that a drop of water will have formed on the end of the bulb.

High Temperature and Low Humidity.—Moisten the wet-bulb wick with precooled water whenever possible in areas where the temperature is high and the relative humidity is low. Moisten the wick thoroughly several minutes prior to and again at the time of ventilation, thus helping to reduce the temperature and prevent the wick from drying out during ventilation. If this procedure is not effective, keep the wick extended into an open container of water between observations.

Temperature of 37 °F (3 °C) and Colder.—Use water kept at room temperature to melt any accumulation of ice on the wet bulb whenever the dry-bulb temperature of 37 °F (3 °C) or colder occurs. Moisten the wick thoroughly at least 15 minutes before ventilation to allow the latent heat to dissipate before ventilation is begun. Do not allow excess water to remain on the wet bulb since a thin ice coating is necessary for accurate data. If the wick is not frozen at wet-bulb temperatures colder than 32 °F (0 °C), induce freezing by touching the wick with clean ice, snow, or other cold objects. If unable to induce freezing of the wick, use the low temperature range of the psychrometric calculator. Moisten the wick again at the time of ventilation.

PREPARATION OF DRY-BULB THERMOMETER.—When appropriate, take the following actions to ventilate the psychrometer.

Dew and Frost Conditions.—When dew or frost are expected, check the dry-bulb thermometer 10 to 15 minutes prior to ventilation. Remove any collection on the thermometer with a soft cloth and allow sufficient time for the dissipation of extraneous heat before ventilation.

Precipitation Conditions.—When a sling psychrometer is used, the dry-bulb temperature must be obtained before ventilation when precipitation is occurring. If there is moisture on the thermometer, wipe it dry with a soft cloth and shield the thermometer from the precipitation as long as necessary. This permits dissipation of any extraneous heat before reading the temperature.

Condition of Saturation.—During dense fog or heavy precipitation, a condition of 100 percent relative humidity may exist and no evaporation from the wet bulb can occur. In this event, the temperature of the wet-bulb is the same as that of the dry-bulb thermometer.

Computation of Dew Point

The dew point temperature is determined from the dry-bulb and wet-bulb temperatures. The relative humidity is determined from the dry-bulb and dew point temperatures.

DETERMINATION OF DEW POINT TEMPERATURE.—The dew point temperature is the temperature to which a given parcel of air must be cooled, at constant pressure and water vapor content in order for saturation to occur. For a given set of dry-bulb and wet-bulb temperatures the dew point is computed as follows:

1. Determine the wet-bulb depression by subtracting the wet-bulb temperature from the dry-bulb temperature.
2. Using the psychrometric computer CP-165/UM compute the dew point temperature as follows:

    a. Using the outer D scale set the arrow at 0° on the observed wet-bulb temperature.
    b. Set the rotating cursor on the value on the D scale equalling the wet-bulb depression.
    c. The dew point temperature is the value on the DP scale that the cursor is on, above the wet-bulb depression value on the D scale.
    d. When the wet-bulb temperature is above 32 °F use the high temperature range.
    e. When the wet bulb is 32 °F and below, use the low temperature range.
    f. When the wet-bulb temperature is 32 °F and below and the wick on the wet-bulb thermometer is ice covered, use the Ti scale instead of the DP scale in step c.

Statistical Dew Point Temperature

At dry-bulb temperature of −35 °F (−37 °C) and colder, assume the dew point with respect to ice is the same as the dry-bulb temperature. Obtain a statistical dew point value for the observation record by converting this temperature to the corresponding dew point with respect to water.

Relative Humidity

The ratio of the actual vapor pressure of the air to the saturation vapor pressure is expressed as a percentage. The relative humidity is not routinely computed and is not required in either

the ship aviation code or the ship synoptic code. The relative humidity is frequently requested though and the observer should become familiar with computing this.

COMPUTATION OF THE RELATIVE HUMIDITY.—To compute the relative humidity, use the psychrometric computer CP-165A/UM. Observe the dry-bulb and wet-bulb temperatures and compute the dew point:

- Using the inner two scales of the psychrometric computer, scales RH and T, set the arrow at 100% RH on the dry-bulb value on the T scale.

- Rotate the cursor until the line is on the dew point value on the T scale.

- Read the percent of relative humidity on the RH scale below the dew point value.

Minimum Thermometer

The minimum thermometer is exposed in the thermoscreen and is mounted to the Townsend support, as seen in figure 1-3-14. Note that the bulb end should rest about 5 degrees below the horizontal.

READING THE MINIMUM THERMOMETER.—The minimum thermometer is read while in the "set" or "operating" position. The reading is taken from the position of the upper or right-hand end of the glass index. Always read the minimum thermometer and then lower and read the maximum thermometer in that order. The same precautions in reading should be used that apply to the air thermometer.

RESETTING THE MINIMUM THERMOMETER.—The carrier stud has a slot in the base permitting the hollow stud to rotate through approximately 85 degrees clockwise, so as to bring the thermometer in a vertical position, bulb end up. Carefully raise the bulb end to a vertical position, and allow the index to sink slowly until it is in contact with the head of the alcohol column. The surface tension of the alcohol column prevents the index from breaking through. The thermometer is then gently rotated back counterclockwise to the operating position. The pin in the slot limits the degree of rotation and holds the thermometer at the correct position when rotated as far as it will go with the bulb end to the left. It is best to reset the minimum thermometer after the maximum thermometer has been read and reset, but always read the

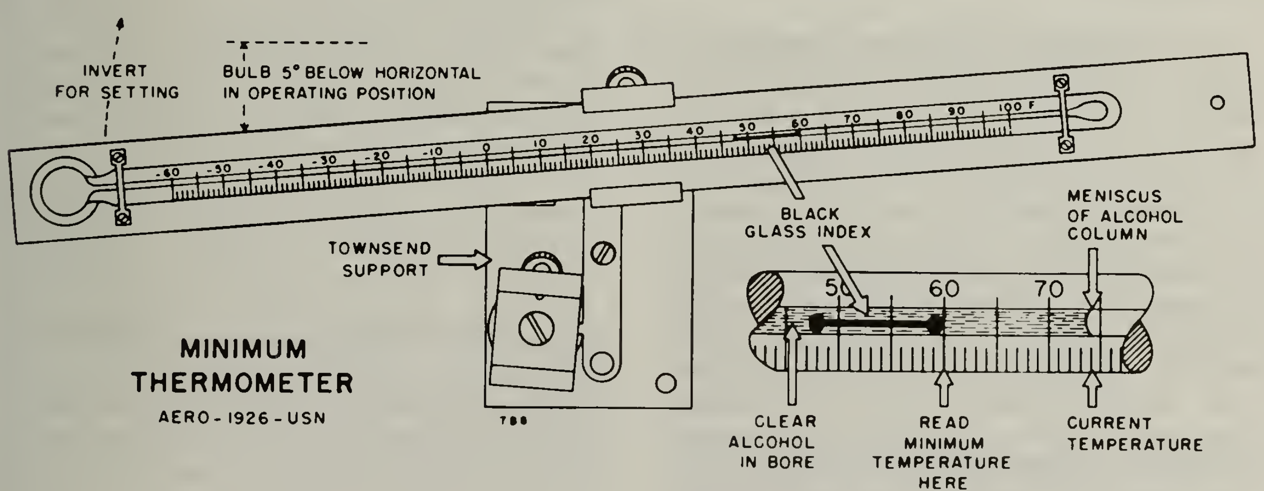

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Figure 1-3-14.—Minimum thermometer.

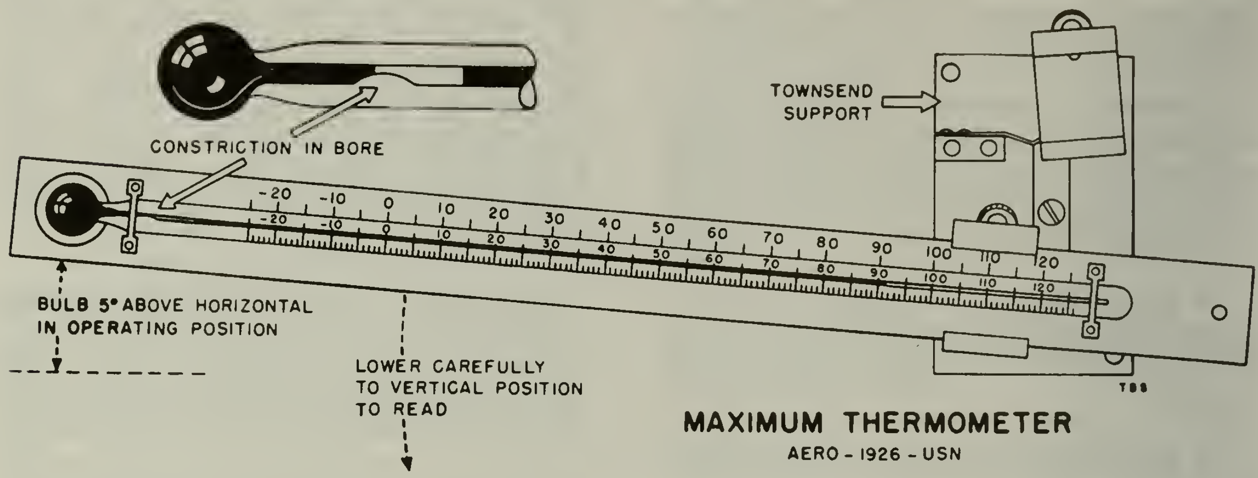

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Figure 1-3-15.—Maximum thermometer.

minimum thermometer before reading and resetting the maximum thermometer.

Maximum Thermometer

The maximum thermometer is exposed in the thermoscreen and is mounted to the townsend support as seen in figure 1-3-15. Note that the bulb end should rest about 5 degrees above the horizontal.

READING THE MAXIMUM THERMOMETER.—Release the locking pawl at the base of the carrier stud, and lower the thermometer to a vertical position, bulb end down. Be careful in lowering, as any slight jar or shock may force some mercury past the constriction into the bulb. The reading is then made from the top of the mercury column, taking the same precautions in reading as prescribed for the air thermometer. In order to prepare the instrument properly for reading, use both hands but take care not to touch the bulb or stem. Lightly grasp the metal back, about midway along its length, between the thumb and first two fingers of the left hand. Then release the pawl with the right hand, and lower the thermometer to a vertical position with the left hand. Greater care must be used during periods of high maximum temperatures because of the greater weight of the long column of mercury.

TO RESET THE MAXIMUM THERMOMETER.—After reading and recording the maximum temperature, the instrument must be reset. The carrier stud is free to rotate when the locking pawl is disengaged, as was done preliminary to the reading. To reset, place a finger or pencil along the left side of the thermometer near the top and impart to it a rapid clockwise rotation. Allow the thermometer to whirl until it comes to rest itself. Do not try to stop it while whirling. Repeat the whirling, if necessary, until the column in the stem has been forced down as far as it will go. When resetting is complete, the top of the mercury column should read the same as the dry-bulb thermometer, within the limits of instrumental errors of the instruments concerned. Next, engage the locking pawl and carefully elevate the bulb end of the thermometer until the pawl catches and holds the carrier. The thermometer is now reset and ready to indicate the ensuing maximum temperature. It is recommended that the minimum thermometer be read before the maximum thermometer so that the index in the minimum thermometer will not be jarred before the reading is made.

EXERCISE (1-3-5)

For items 1 through 9, complete the following statements.

1. **When reading the air thermometer and your eye level is too low, the temperature will be read too ___________ due to the error of parallax.**

2. **The AN/GMQ-29 is used to obtain psychrometric values, the dry-bulb and dew-point temperatures are read to the nearest ___________ degree directly from the digital windows.**

3. **When using the electric psychrometer, thoroughly saturate the wet-bulb wick with pure water, taking every precaution to prevent water from contacting either the thermometer tube or the ___________.**

4. **When using the sling psychrometer, select a shady area with no obstructions within 3 to 4 feet and face into the ___________.**

5. **During periods of dense fog or heavy precipitation, ___________ evaporation from the wet bulb may take place.**

6. **To determine dew point temperature using computer CP-165/UM, you first must obtain the dry-bulb and wet-bulb temperatures. Second, you must obtain the ___________ depression.**

7. **To determine relative humidity using computer CP-165/UM, you must use the dew point temperature and the ___________ temperature.**

8. **The maximum thermometer bulb end should rest about 5 degrees ___________ the horizontal.**

9. **The minimum thermometer bulb end should rest about 5 degrees ___________ the horizontal.**

FORMS

CNOC 3140/7 Entries

TEMPERATURE (COLUMN 7).—Enter the dry-bulb temperature to the nearest whole degree Fahrenheit; e.g., 35 for 34.5, 106 for 106.4°. Prefix subzero temperatures with a minus sign; e.g., −7. Enter "M" for missing data.

DEW POINT TEMPERATURE (COLUMN 8).—Enter the dew point temperature to the nearest whole degree Fahrenheit. Enter "M" for missing data. Prefix subzero dew point temperatures with a minus sign. Enter statistical data in parentheses; i.e., enter the water equivalent of the dry-bulb temperature when the air temperature is −35°F (−37°C) or below.

MAXIMUM OR MINIMUM TEMPERATURE (Tn/xTn/x), (COLUMN 13).—

1. Encode maximum and minimum temperatures in degrees Fahrenheit for stations designated

to use Airways and in degrees Celsius for stations designated to use METAR.

TIME (GMT)	TEMPERATURE
0000	Maximum for past 12 hours
0600	Maximum for past 24 hours
1200	Minimum for past 12 hours
1800	Minimum for past 24 hours

2. Encode positive values using the tens and units digits. Subtract negative values from 100 and encode the tens and units digits of the result. Examples follow:

Temperature Extreme	Tn/xTn/x
105	05
25	25
5	05
0	00
–5	95
–15	85

24-HOUR MAXIMUM TEMPERATURE (COLUMN 66).—Enter the maximum temperature of the day (LST) to the nearest whole degree Fahrenheit for stations designated to use Airways and degrees Celsius for stations designated to use METAR. The only other permissible entry is the letter "M" (missing) by stations which operate for less than 24 hours per day, and only when they cannot accurately determine the maximum temperature.

24-HOUR MINIMUM TEMPERATURE (COLUMN 67).—Enter the minimum temperature of the day (LST) to the nearest whole degree Fahrenheit for stations designated to use Airways and degrees Celsius for stations designated to use METAR. The only other permissible entry is the letter "M" (missing) by stations which operate for less than 24 hours per day, and only when they cannot accurately determine the minimum temperature.

CNOC 3140/8 Entries

TEMPERATURE (COLUMN 7).—Enter the dry bulb temperature to the nearest 0.1 °F. Prefix subzero temperatures with a minus sign. Enter "M" for missing data.

DEW POINT TEMPERATURE (COLUMN 8).—Enter the dew point temperature to the nearest whole degree Fahrenheit. Prefix subzero temperatures with a minus sign. Enter "M" for missing data.

SEA WATER TEMPERATURE (COLUMN D).—Enter the current sea water temperature to the nearest 0.1 °C.

EXERCISE (1-3-6)

For items 1 through 7, complete the following statements. In items 1 through 4 refer to CNOC 3140/7 land SURFACE OBSERVATIONS form.

1. Enter the dry-bulb temperature (Column 7) to the nearest ____________degree Fahrenheit.

2. Enter the dew point temperature (Column 8) to the nearest ____________degree Fahrenheit.

3. When entering the maximum temperature (Column 13) on the 0600Z observation, it will be for the past____________hours.

4. When entering the 24-hour maximum temperature (Column 66) and minimum temperature (Column 67) and the data cannot accurately be determined, you would enter an____________in each column.

In items 5 through 7 refer to CNOC 3140/8 shipboard surface observation form.

5. Enter the dry bulb temperature (Column 7) to the nearest ____________degree Fahrenheit.

6. Enter the dew point temperature (Column 8) to the nearest ____________degree Fahrenheit.

7. Enter the sea water temperature to the nearest tenth degree ____________.

TEMPERATURE EFFECTS ON THE HUMAN BODY

Aviators and personnel engaged in outside tasks are very interested in the effects of an air temperature on their bodies. As an Aerographer's Mate you may frequently be asked to explain how wind chill, heat stress, and water immersion can affect them.

Wind Chill Equivalent Temperature

The temperature of the air is not always a reliable indicator of how cold a person feels outdoors. Other weather elements such as wind speed, relative humidity, and heat from the sun are an influence. In addition, the type of clothing worn as well as the state of health and metabolism of an individual has an influence on how cold they feel. Generally, "coldness" is related to the loss of heat from exposed flesh; one can assume this coldness to be proportional to the measured rate of heat loss from an object.

- The wind chill index or equivalent temperature is based upon a neutral skin temperature of 33°C (91.4°F). With physical exertion, the body heat production rises, perspiration begins, and heat is removed from the body by vaporization. The body also loses heat through conduction to cold surfaces with which it is in contact and in breathing cold air that results in the loss of heat from the lungs. The index, therefore, does not take into account all possible

Table 1-3-1.—Wind chill equivalent temperature

DRY BULB TEMPERATURE (°F)

WIND VELOCITY (MPH)	45	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
4	45	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	4
5	43	37	32	27	22	18	11	6	0	-5	-10	-15	-21	-26	-31	-36	-42	-47	-52	5
10	34	28	22	16	10	3	-3	-9	-15	-22	-27	-34	-40	-46	-52	-58	-64	-71	-77	10
15	29	23	16	9	2	-5	-11	-18	-25	-31	-38	-45	-51	-58	-65	-72	-78	-85	-92	15
20	26	19	12	4	-3	-10	-17	-24	-31	-39	-46	-53	-60	-67	-74	-81	-88	-95	-103	20
25	23	16	8	1	-7	-15	-22	-29	-36	-44	-51	-59	-66	-74	-81	-88	-96	-103	-110	25
30	21	13	6	-2	-10	-18	-25	-33	-41	-49	-56	-64	-71	-79	-86	-93	-101	-109	-116	30
35	20	12	4	-4	-12	-20	-27	-35	-43	-52	-58	-67	-74	-82	-89	-97	-105	-113	-120	35
40	19	11	3	-5	-13	-21	-29	-37	-45	-53	-60	-69	-76	-84	-92	-100	-107	-115	-123	40
45	18	10	2	-6	-14	-22	-30	-38	-46	-54	-62	-70	-78	-85	-93	-102	-109	-117	-125	45

losses of the body. It does, however, give a good measure of the convective cooling that is the major source of body heat loss.

- Table 1-3-1 depicts equivalent temperatures for various combinations of wind and temperature. For example, a combination of 20°F and a 10-mph wind has the same cooling power as a temperature of 3 °F.

Heat Stress

The overall effect of excessive heat on the body is known as heat stress. Important factors contributing to heat stress are air temperature, humidity, air movement, radiant heat from incoming solar radiation (isolation), bright lights, stove or other source, atmospheric pressure, physiological factors which vary among people, physical activity, and clothing.

Of the above factors, temperature and humidity can be controlled by air conditioning. Air movement may be controlled by fans; even a slight breeze is usually effective in reducing heat stress in hot, muggy weather. However, at very high temperatures (above normal body temperature of about 98.6°F), winds above 10 miles per hour can cause severe dehydration or increase heat stress in a shaded area by adding more heat to the body. However when the body is exposed to direct sunlight the effect of wind is nearly always to reduce heat stress. Radiant heating can be reduced by shielding or by moving away from the source.

There are natural limits on how much physical conditioning can alter physiological heat responses. Two obvious physical necessities in reducing heat stress are getting enough fluids to replace perspiration loss and reducing physical activity during periods of extreme heat. The choice of clothing can be helpful since absorbent, light-colored materials provide more comfort under hot, humid conditions.

Under normal conditions, temperature and humidity are the most important elements influencing comfort. The temperature-humidity index is based on human physiology and clothing science. This index is called apparent temperature and is a measure of what hot weather "feels like" to the average person for various temperatures and relative humidities. Table 1-3-2 gives apparent temperature versus actual air temperature and relative humidity.

As an example of how to read the graph in Table 1-3-2, an air temperature of 90 °F combined with a 60% relative humidity feels like 100°F.

Table 1-3-2.—Apparent heat stress temperature

RELATIVE HUMIDITY (%)

APPARENT TEMPERATURE

AIR TEMPERATURE (°F)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
140	125																				
135	120	128																			
130	117	122	131																		
125	111	116	123	131	141																
120	107	111	116	123	130	139	148														
115	103	107	111	115	120	127	135	143	151												
110	99	102	105	108	112	117	123	130	137	143	150										
105	95	97	100	102	105	109	113	118	123	129	135	142	149								
100	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144						
95	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136				
90	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122		
85	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86	87	88	89	91
75	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80
70	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

While interpretation of what a given apparent temperature feels like may vary from one person to another, the differences among various apparent temperatures are objective and based on physiological research. In areas of low relative humidity, i.e., 30% or less, the apparent temperature is about the same as the air temperature or even lower.

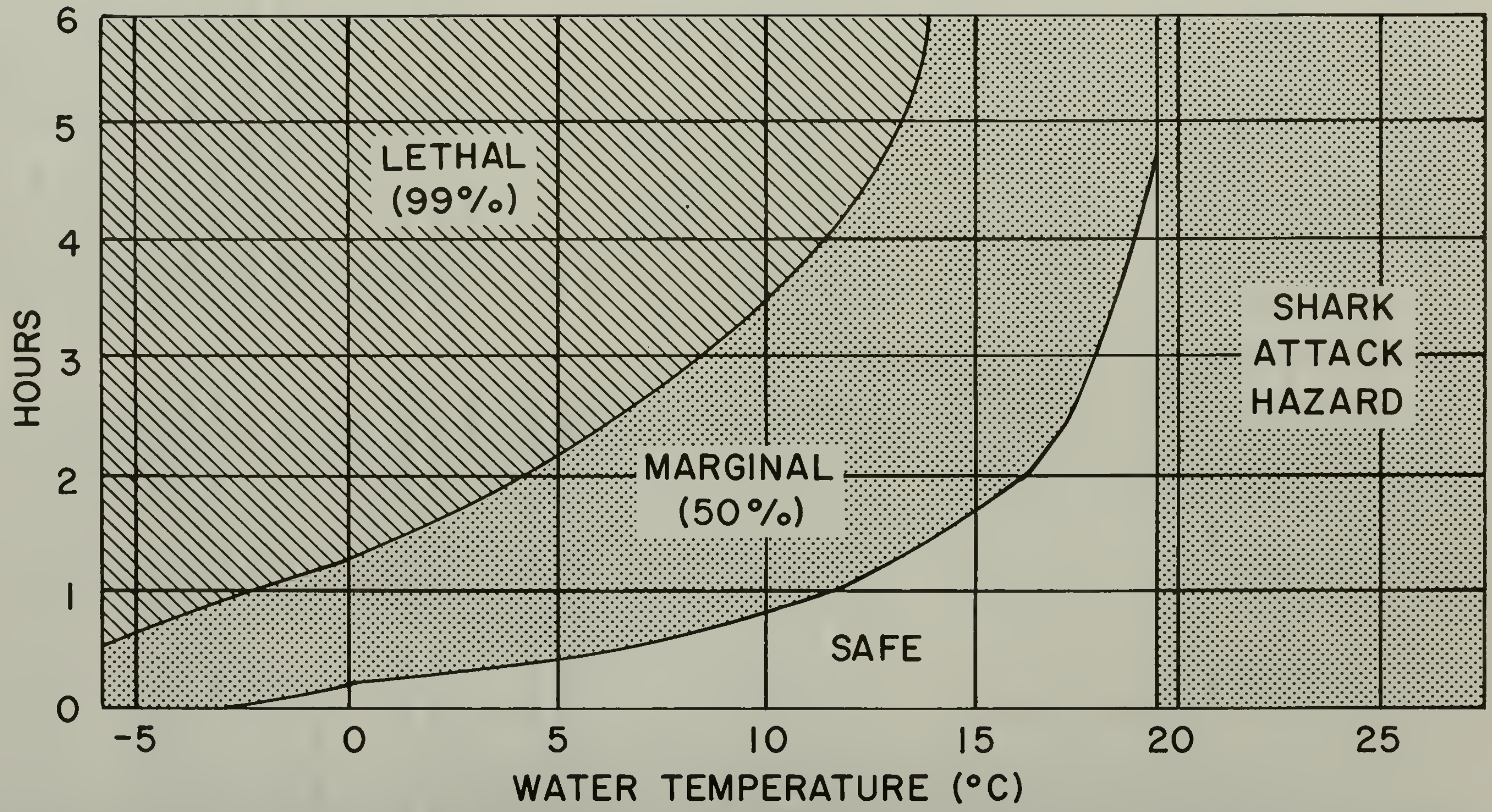
Sea Water Temperature During Immersion

When you are immersed in water, one major factor on the length of time you can survive is the sea water temperature. Some other factors are the sea condition (height and length of the waves), your ability to swim, your physical condition, and clothing.

When you are immersed in water your body loses heat to the water by conduction. This heat loss rate depends primarily on the temperature of the water.

If you are immersed long enough, unconsciousness or death occurs (see Table 1-3-3). This table assumes that the sea condition is not a factor, the person is an average swimmer in average physical condition with no special clothing.

Table 1-3-3.—Survival during water immersion



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EXERCISE (1-3-7)

For the following items 1 through 3, read the information, fill in the missing words and, using Table 1-3-1, determine wind-chill temperature.

1. The outside air temperature is not always a reliable indication of how cold you may feel. Other weather elements such as____________, ____________, and____________will effect this temperature also.

Now, compute the wind-chill temperature and enter the values in the space provided.

2.	**Wind velocity (mph)**	**40**
	Dry bulb temperature (°F)	**30**
	Wind-chill temperature (°F)	____________
3.	**Wind velocity (mph)**	**10**
	Dry bulb temperature (°F)	**5**
	Wind-chill temperature (°F)	____________

For items 4 through 6, read the information, fill in the missing words using table 1-3-2 to determine the apparent heat stress temperature.

4. High temperature, high humidity, and low air movement are some of the factors contributing to____________ ____________.

Now, determine the apparent heat stress temperature and enter the values in space provided.

5.	**Relative humidity (%)**	**50**
	Dry bulb temperature (°F)	**100**
	Apparent temperature (°F)	____________
6.	**Relative humidity (%)**	**100**
	Dry bulb temperature (°F)	**85**
	Apparent temperature (°F)	____________

For items 7 through 11, read the information, fill in the missing words using table 1-3-3 to determine the possibility of survival while immersed in water.

7. When you are immersed in water your body loses heat to the water by conduction. This heat loss rate depends primarily on the water ____________.

Now, determine the possibility of survival while immersed in water.

8.	**Time (hours)**	**3.0**
	Water temperature (°C)	**5.0**
	Possibility of survival	____________
9.	**Time (hours)**	**2.0**
	Water temperature (°C)	**18.0**
	Possibility of survival	____________

WIND

The atmosphere is essentially an ocean of air surrounding the earth with gas. Temperature is unevenly distributed over the earth's surface, varying with latitude and with the seasons. Therefore, all of the earth's atmosphere is continually in a state of fluid motion. In our study of the weather from day to day or even for longer periods, two aspects of the atmospheric circulation are of great importance: The transport of air from one region to another over the earth's surface; that is, air mass movements. The changes or transformations produced in depth within the air masses themselves, the changes are largely produced or affected by vertical motions within the air masses.

Wind is the observed effect of horizontal transport of air masses over the earth's surface. This air transport, or motion parallel to the earth's surface, is apparent to the observer as the surface wind and the upper wind.

The surface wind is defined as air in horizontal motion adjacent to and parallel to the earth's surface. This usually includes observations within an air stratum 10 to 50 feet above the ground.

The upper winds or "winds aloft" are defined as air in horizontal motion parallel to the earth's surface at designated standard levels above the surface within the free atmosphere.

Learning Objective: Define and identify the techniques for reporting individual wind elements.

DEFINITIONS

Wind direction. Wind direction is the direction FROM which the wind is blowing. It is reported with reference to true north, and is expressed to the nearest 10 degrees or to 16 points of the compass.

Wind speed. Wind speed is the rate of motion of the air in a unit of time. Wind speed can therefore be measured in a number of ways. The Naval Oceanography Command measures the speed of the wind in knots; that is, it measures the wind in nautical miles per hour.

Gust. Gust is defined as rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls.

Squall. Squalls are defined as a sudden increase in wind speed of at least 15 knots and sustained at 20 knots or more for at least 1 minute. The occurrence of squalls is indicative of turbulence near the surface.

Peak gust. The highest instantaneous wind speed observed or recorded.

Wind shifts. "Wind shift" is a term applied to a change in wind direction of 45 degrees or more which takes place in less than 15 minutes. Wind shifts are normally associated with a cold-frontal passage.

Changes of wind direction may also result from other causes such as katabatic or foehn winds, sea breezes, and thunderstorms. In such cases, the change of direction may be gradual or abrupt, and may or may not be accompanied by significant changes of other weather elements. Wind shifts are reported when believed to be associated with frontal movement, or when considered important for the safety of aircraft operations.

Variable wind direction. Wind direction is considered to be variable when it fluctuates by 60 degrees or more during the period of observation.

Light wind. The wind is considered to be light when the speed is 6 knots or less.

Calm wind. The common term used to describe the absence of any apparent motion of the air.

EXERCISE (1-3-8)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

1. ________Wind direction

2. ________Wind speed

3. ________Gust

4. ________Squall

5. ________Peak gust

6. ________Wind shifts

7. ________Variable wind direction

8. ________Light wind

9. ________Calm wind

a. Wind speed is 6 knots or less

b. The rate of motion of the air in a unit of time

c. The highest instantaneous wind speed recorded

d. Wind direction fluctuates by 60 degrees or more

e. Absence of any apparent motion of the air

f. Wind is blowing from

g. A sudden increase in wind speed sustained at 20 knots for at least 1 minute

h. A change in wind direction of 45 degrees or more in less than 15 minutes

i. A rapid fluctuation in wind speed with a variation of 10 knots or more between peaks and lulls

DETERMINING WIND

To properly define any motion, the direction of motion and the velocity must be stated. All wind observations must, therefore, be made in terms of wind direction and wind velocity.

Wind Direction

The direction of the wind is always *the direction from which the wind is blowing*. Thus, air flow from north to south is expressed as a "North Wind." Direction is expressed in several ways, all related in sense but differing in detail.

Wind directions in degrees of azimuth are directions expressed in degrees from True North through 360 degrees measured clockwise from the true meridian, where 000° or 360° is north, 090 degrees is east, 180 degrees is south.

Wind direction may also be expressed in one of the 16 points of the compass as seen in figure 1-3-16. The four cardinal points of the compass

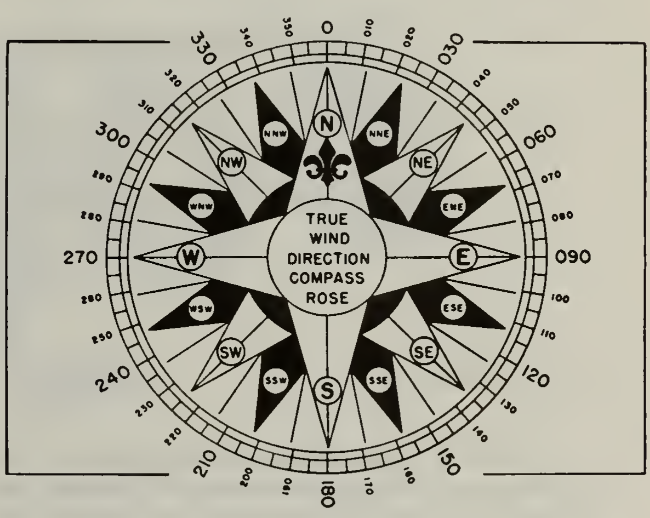

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Figure 1-3-16.—Cardinal points of the compass.

are north, east, south, and west. The Inter-cardinal points are northeast, southeast, southwest, and northwest. Between adjacent cardinal and inter-cardinal points are additional divisions such as north-northeast, east-northeast, east-southeast, etc. These are the expressions of direction most commonly used by the general public.

Wind Velocity

Velocity is the distance traversed per unit of time. Since time is a common unit of all systems of measurement, wind velocity expressed in any chosen linear unit may be readily converted to corresponding values of any other system.

The following are conversion factors for the most commonly used velocity units:

1 meter per second	Equals 1.9425 knots.
	Equals 2.2369 miles per hour.
1 nautical mile per hour (knot)	Equals 0.5148 meters per second.
	Equals 1.1516 miles per hour.
	Equals 1.8532 kilometers per hour.
1 mile per hour (statute)	Equals 0.447 meters per second.
	Equals 0.8684 knots.
	Equals 1.6094 kilometers per hour.

AN/GMQ-29( )

DISPLAY PANEL.—Wind direction and wind speed are updated every 14 seconds and displayed on the readout panel through a very complex system of electronics data reception and computations.

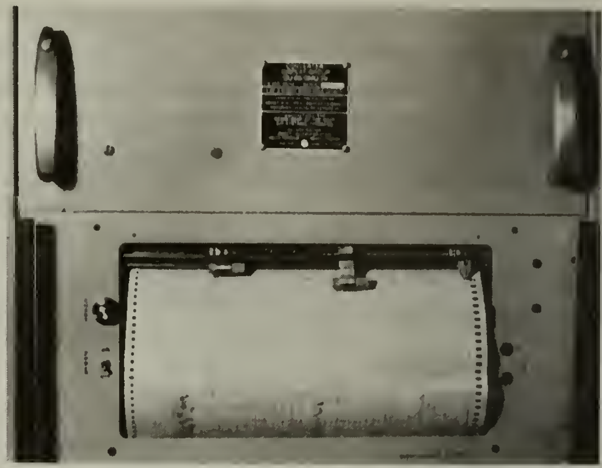

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Figure 1-3-17.—Analog recorder RO-447/GMQ-29.

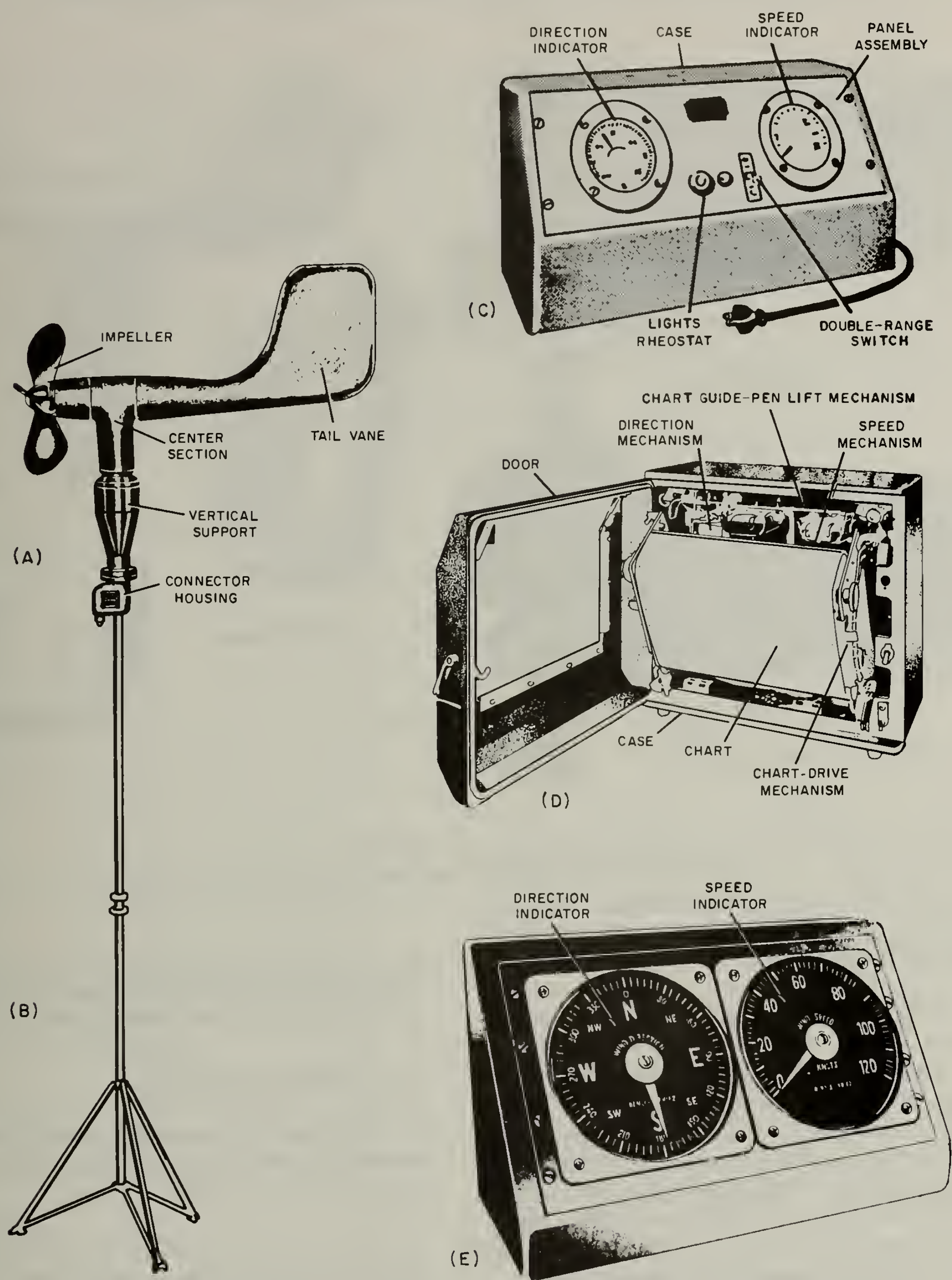
RECORDER RO-447/GMQ-29.—This is an analog recorder (shown in figure 1-3-17) using inputs from the UMQ-5( ) wind system. The recorder records wind direction and wind speed.

AN/UMQ-5( )

Wind Measuring Set AN/UMQ-5( ) is the standard equipment designed to provide a visual indication and/or printed record of wind direction and speed values (figure 1-3-18). Various options of the system are provided to permit continuous recording of wind direction and speed values at several measuring sites.

AN/PMQ-3( )

Wind Measuring Set AN/PMQ-3, -3A, -3B, or -3C is a portable hand anemometer. It is a combination wind direction and speed indicating unit which indicates direction to 360 degrees and speed from 0 to 60 knots. (The AN/PMQ-3 is shown in figure 1-3-19.)



(A) Transmitter ML-400( )/UMQ-5
(B) Suport MT-535/UMQ-5
(C) Indicator ID-300( )/UMQ-5
(D) Recorder RD-108( )/UMQ-5
(E) Indicator ID586( )/UMQ-5

209.119

Figure 1-3-18.—Wind measuring set AN/UMQ-5( ).

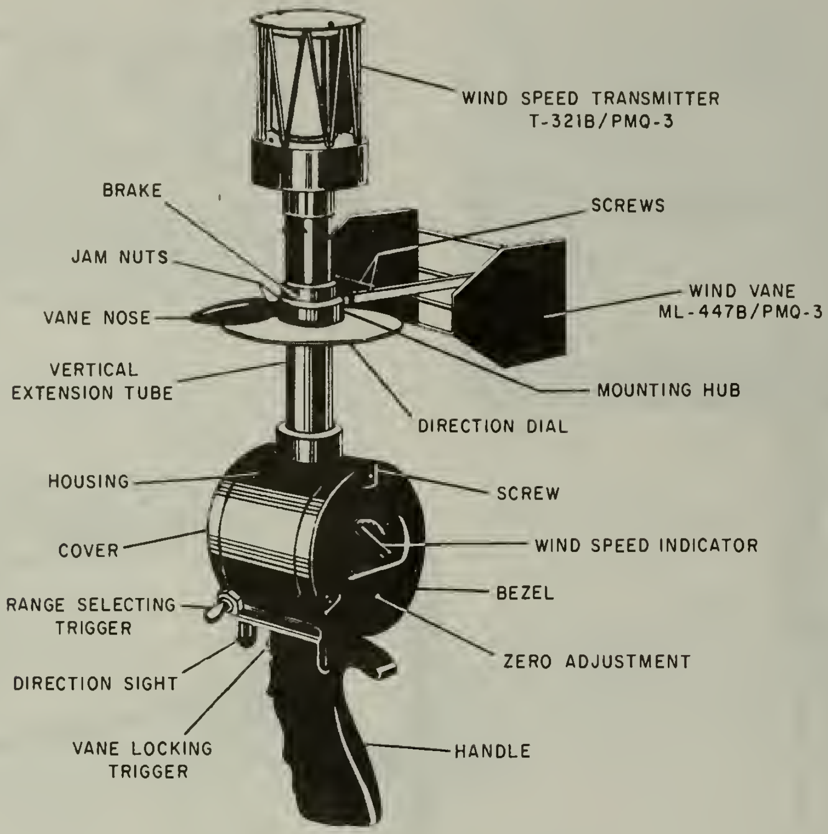


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Figure 1-3-19.—Wind measuring set AN/PMQ-3( ).

Shipboard Wind System Type B3

Type B3 Wind Indicating Equipment as seen in figure 1-3-20 is installed aboard ships to determine wind speed and direction. Aboard aircraft carriers this system is supplemented with a wind recorder of the type used with the shore system (figure 1-3-18). However, it only records the apparent wind direction and speed, which must then be used to compute true wind direction and speed. The several methods used to do this are discussed later in this lesson.

WIND COMPUTATION

AN/GMQ-29 (Display)

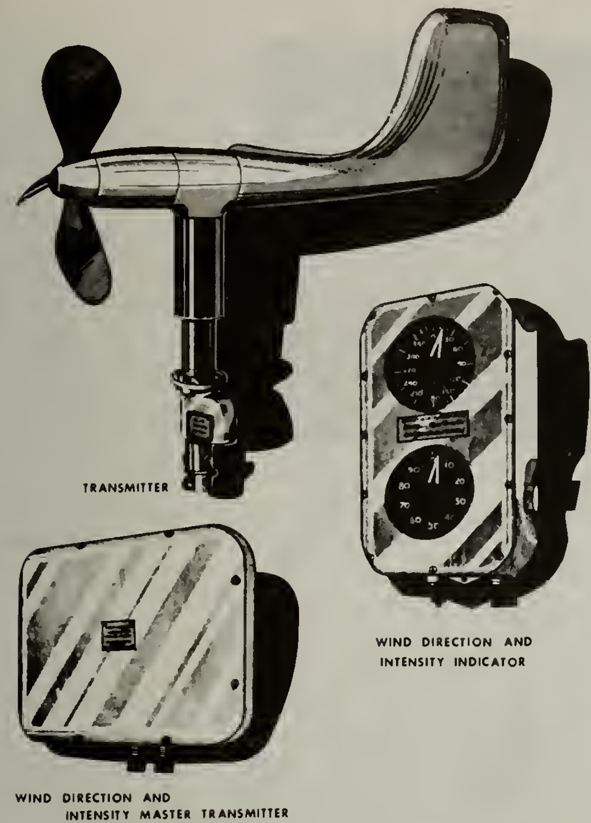
Wind direction is displayed on the GMQ-29 in whole degrees (figure 1-3-21). The wind speed is displayed in knots (figure 1-3-22). Both readings that appear on the display panel are an average that is updated every 14 seconds.

AN/GMQ-29 (Recorder)

The recorder is updated every 16 seconds, so for all practical purposes the wind recorder is instantaneous (see figure 1-3-23).

The recorder records the wind direction on the left side of the chart and speed on the right side of the chart (figure 1-3-24).

When using the AN/GMQ-29 to obtain wind data, the observed wind direction and speed are obtained from the display panel (see figures 1-3-23 and 1-3-24). Information on gusts or squalls is obtained from the recorder.



209.118
Figure 1-3-20.—Type B3 wind indicating equipment (shipboard).

Figure 1-3-21.—Wind direction, AN/GMQ-29.

Figure 1-3-22.—Wind speed, AN/GMQ-29.

The direction on the recorder chart has lines drawn for every 10 degrees, but the lines are labeled for every 30 degrees.

The speed on the recorder chart has a range from 0 to 120 knots. Each vertical line represents 5 knots and the lines are labeled every 10 knots.

AN/UMQ-5( )

The AN/UMQ-5 wind measuring set has four main parts as seen in figure 1-3-18. However, we only cover the procedure on how to obtain the wind data. Information on the equipment is covered in a later lesson.

INDICATOR (ID586( )/UMQ-5).—This indicator as seen in E of figure 1-3-18 provides a visual indication of the present wind direction and speed. Direction is indicated in both compass points and degrees. The speed dial indicates wind speed from 0 to 120 knots. The indicator is read directly; that is, the pointers indicate the true wind at that instant.

INDICATOR (ID300( )/UMQ-5).—This is a second type of indicator that may be used with the wind measuring set (C of figure 1-3-18). This indicator is slightly different from, but serves the same function, as the ID586( )/UMQ-5 indicator.

RECORDER (RD108( )/UMQ-5).—The recorder is more useful than the indicator since it can give you the average wind as well as gusts and squalls. This recorder is similar to the AN/GMQ-29. The recorder chart may be different; however, the procedure is the same for obtaining the wind direction and wind speed (see figure 1-3-25).

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Figure 1-3-23.—AN/GMQ-29 wind recorder.

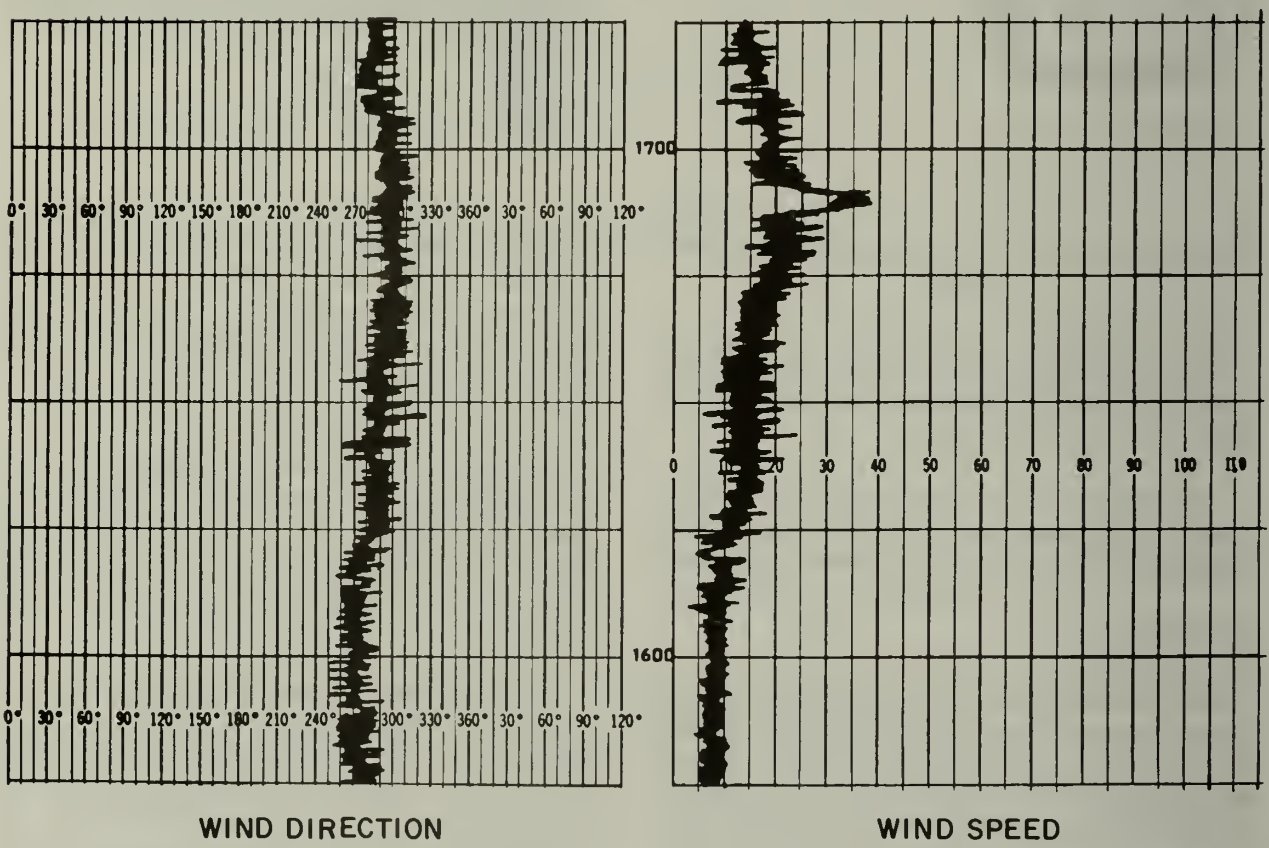

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Figure 1-3-24.—AN/GMQ-29 recorder chart.

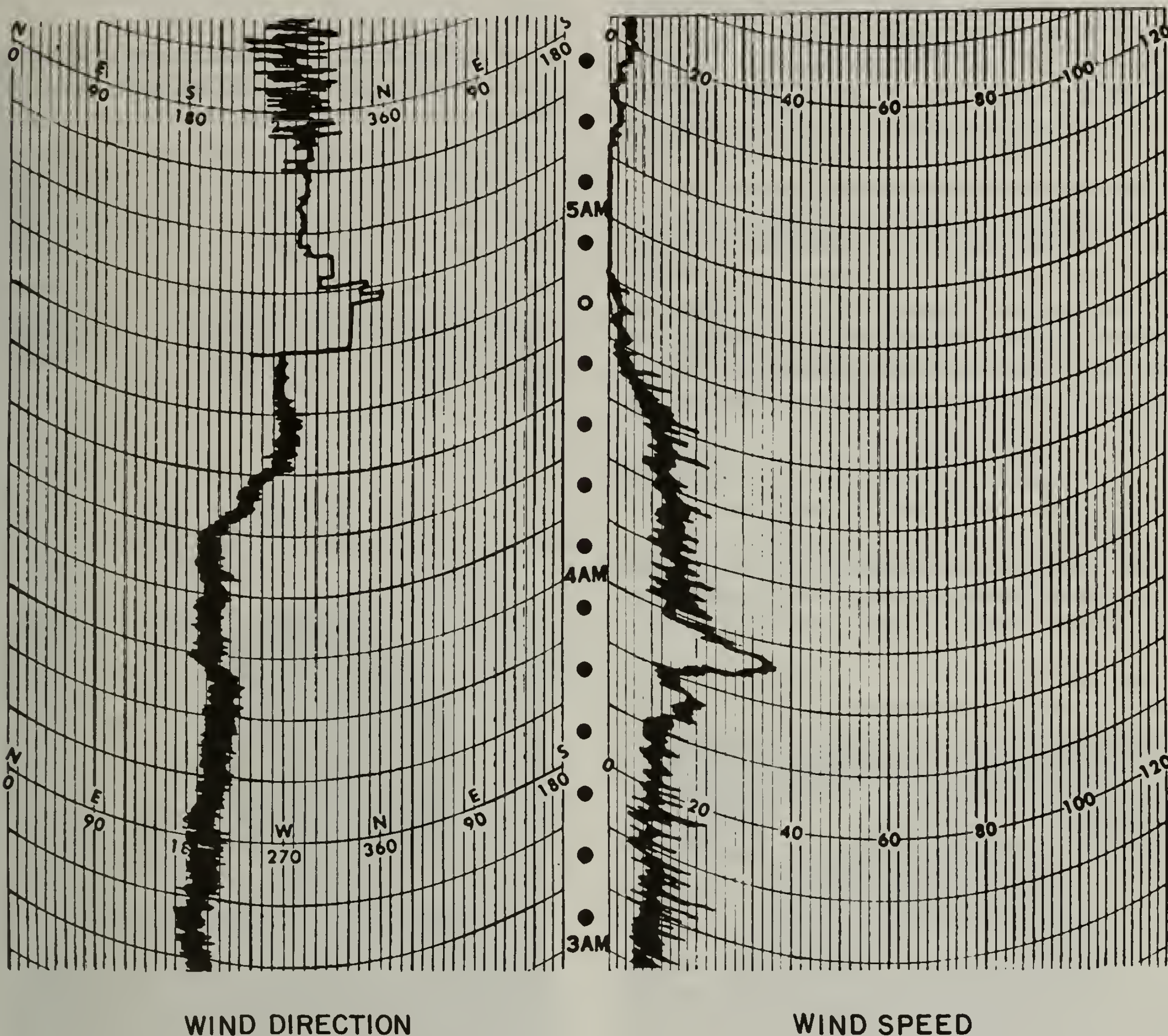

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Figure 1-3-25.—AN/UMQ-5( ) recorder chart.

The wind direction on the recorder chart has lines drawn for every 10 degrees, but the lines are labeled for every 90 degrees along with the cardinal compass points, NORTH, EAST, SOUTH, and WEST.

The wind speed on the recorder has a range from 0 to 120 knots. Each vertical line represents 2 knots, and the lines are labeled every 20 knots.

AN/PMQ-3

The main purpose for an AN/PMQ-3 is for a backup system. It is a portable hand anemometer that can be carried any place that wind direction and wind speed are required.

OPERATIONS PROCEDURE.—The wind, upon striking the small cylindrical turbine (figure 1-3-19) in the transmitter, causes the

turbine to rotate. The turbine is linked to a small electrical generator which produces a voltage proportional to the speed of the turbine. The voltage is transmitted to the indicator, which is a voltmeter graduated in knots. The indicator has two scales, graduated from 0 to 15 knots and from 0 to 60 knots. The upper trigger on the handle controls the scale to be used.

The direction unit is a twin-tailed assembly with a pointer (vane nose) which faces into the wind when the brake is released by depressing the vane locking trigger. The index pointer on the vane is then aligned on the direction dial with the direction from which the wind is blowing. To make an accurate direction reading, follow this procedure:

- Choose a location where there is unobstructed wind flow from all directions.

- Grasp the instrument by the handle and hold it in an approximately vertical position at arm's length with the sight at eye level.

- Aim the instrument at a fixed orientation point by aligning the center of the slot in the front of the sight with the center of the strip between the two slots on the rear sight and the fixed orientation point.

- Press and hold the vane locking trigger. Note the reading on the 0-60 (upper) scale on the wind speed indicator.

- If the wind speed reading is less than 15 knots as indicated on the 0-60 scale, press the range-selecting trigger on the side of the housing (3B and 3C models) or handle (3 and 3A models) and observe the indication on the 0-15 scale.

CAUTION: The range-selecting trigger should not be pressed if the initial observation of the wind speed indicator indicates a wind speed in excess of 15 knots as mechanical damage may result due to slamming the pointer.

- The instant the wind speed indication is noted, release the vane locking trigger and carefully lower and tilt the instrument to observe the wind direction reading on the direction dial.

CAUTION: After the vane locking trigger is released, care must be taken not to disturb the vane's position until the direction reading is made.

- Observe the wind direction reading in whole degrees and then record both the wind direction and speed readings.

The equipment is issued ready for use and comes stowed in a carrying case containing a spare wind speed transmitter and a spare wind vane. The instrument should always be replaced in this carrying case after use. Special care should be taken in removing the anemometer from the case and replacing it in the case because damage may easily result to the wind vane section.

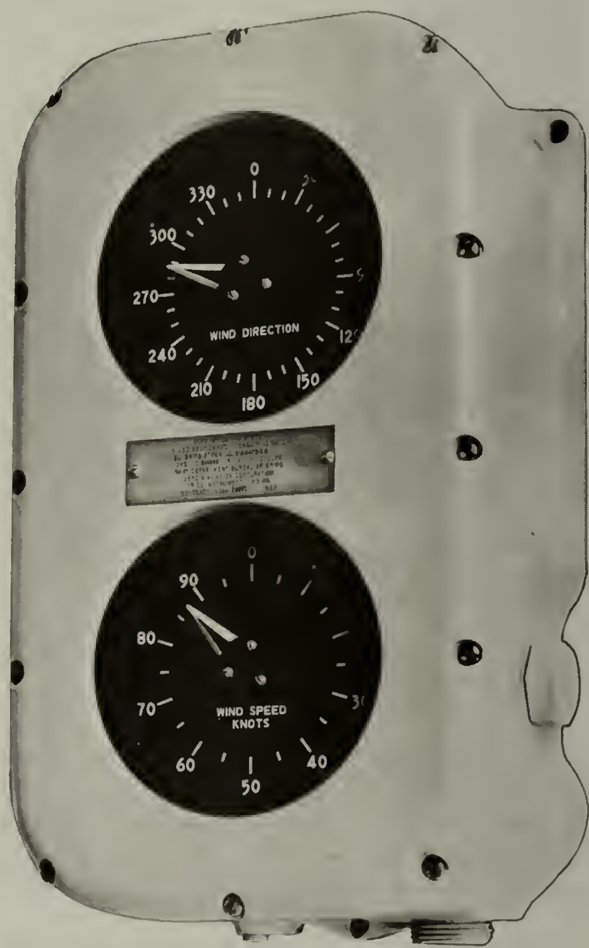

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Figure 1-3-26.—Synchro repeater showing apparent wind velocity and direction.

Shipboard System Type B3

This equipment is under the cognizance of NAVSEA and is serviced by the IC electricians. The only responsibility the Aerographer has, in connection with this equipment, is reading the indicated data and maintaining the charts and inkwells on the recorder unit. If errors appear to exist in the readings obtained from the equipment, notify the IC electricians.

TYPE B3 INDICATOR.—The synchro-repeater of the Type B3 Wind Measuring Set has two dials as seen in figure 1-3-26. One indicates the wind direction relative to the bow of the ship and is graduated in 5 degree increments, and one indicates the speed of the wind in knots. The indicators will give you what is known as the "apparent wind direction and speed." To obtain true direction, you must know the ship's heading.

SHIP DIRECTION.—Most Navy ships provide heading information by means of a gyro compass system which indicates true north. To back this up, and as a primary indicator in some small ships a magnetic compass is used. The simplest magnetic compasses contain magnets whose south ends tend to seek the Earth's north magnetic pole, thus giving the compass its directive force.

Magnetic compasses used in the Navy are highly sophisticated instruments. (Refer to figure 1-3-27.)

SHIP SPEED.—Generally speaking, both the engine revolutions and the log are used to provide indicators of speed through the water. Actual speed over the ground that a ship makes cannot be determined unless wind and current are taken into consideration. (Refer to figure 1-3-28.)

If, by chance a gyro repeater and a ship's speed indicator are not available in your office, the information may be obtained by contacting the bridge.

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Figure 1-3-27.—Compass (ship direction).

69.42

Figure 1-3-28.—Underwater speed log indicator.

SHIPBOARD PROCEDURES.—Shipboard procedures for determining wind speed and direction differ from land-station procedures because the ship is moving *and* the air is moving—sometimes they move in the same direction, sometimes in opposite directions, and sometimes at an angle to each other.

The movement of the ship affects the wind speed observed by both the ship's anemometers and hand-held anemometers. The wind direction is observed in relation to the ship's bow so that the wind direction in relation to true north is affected by the ship's direction. The wind speed and direction with the effect of the ship's speed and direction is the apparent or relative wind. The wind speed and direction minus the effect of the ship's speed and direction is the true wind. The true wind can be computed by one of three methods: (1) True Wind Computer CP-264/U, (2) Maneuvering Board Method, and (3) Plotting Board Method. Refer to NAVOCEANCOMINST 3144.1( ) for more details.

Since the true wind must be computed, the chance of committing an error is increased. The wind data reported in the ship synoptic code is used as criteria for wind, storm, and high seas warnings. Care must be taken whenever computing true wind data.

OBSERVING WIND DATA.—Wind data can be observed using the following methods. The order given is also the priority to use. Wind data is observed from the speed and direction indicators of the installed anemometer, by use of a hand-held anemometer or by visually estimating the true wind direction and speed. Visual estimation should be used only when the installed and hand-held anemometers are inoperative or not available. Anemometers measure the apparent wind speed and indicate the apparent wind direction. When the wind data is visually estimated the true wind speed and direction are directly derived. Estimate wind speed in accordance with criteria listed in Appendix VIII.

General Instructions for Using Anemometers.—Ensure that the ship's course is steady throughout the period of observing the wind. Never observe the wind while the ship is turning. Observe the speed and direction for a 1-minute period noting the following:

1. The predominate (average) wind speed.
2. The peaks and lulls in wind speed, checking for gust and squall criteria.
3. The predominate (average) wind direction.
4. The degrees of variability of the wind direction, checking for variability criteria.
5. Wind shifts.

Use of Installed Anemometers.—This is the preferred method of observation. The wind data is taken from the indicator panel which gives both speed and direction. When using an installed anemometer the data observed should always be compared with the wind conditions as they appeared while other elements of the observation were observed outside to ensure that the anemometer or indicator panel is not malfunctioning. If two anemometers are installed, ensure that the windward anemometer is used.

Use of Hand-held Anemometer.—If anemometers are not installed, if the installed anemometer is inoperative, or if the data from it is in doubt, the hand-held anemometer should be used. The operations procedure is the same as we covered in the land section. However, there are some things that must be done differently.

To use the hand-held anemometer, choose an observation site on the windward side of the ship as far upwind as possible. If the wind is from the stern, go aft; if it is from the bow, go forward. Stand facing parallel to the ship's centerline and into the wind.

NOTE: Unless the wind is blowing parallel to the ship's direction, the wind will be at an acute angle while facing parallel to the ship's center line. Proceed as follows:

1. Grasp the instrument by the handle and hold it in an approximately vertical position at arm's length with the sight at eye level.
2. Aim the instrument at an imaginary point on the horizon by aligning the center of the slot in the front of the sight with the center of the strip between the two slots on the rear sight.

3. Press and hold the vane locking trigger. Note the reading on the 0-60 (upper) scale on the wind speed indicator. If the wind speed reading is less than 15 knots as indicated on the 0-60 scale, press the range selecting trigger on the side of the housing (3B and 3C models) or handle (3 and 3A models) and observe the indication on the 0-15 scale.

CAUTION: The range-selecting trigger should not be pressed if the initial observation of the wind speed indicator indicates a wind speed in excess of 15 knots. Mechanical damage may result due to slamming the pointer.

4. Note the motion of the wind vane as it moves between the extremes of variability; release the vane locking trigger when the vane is in the position of the predominant (average) wind direction. Carefully lower and tilt the anemometer and note the wind direction reading on the direction dial. If the wind is being observed facing aft, the direction must be converted in relation to the bow; add 180 degrees for directions 0 through 90 degrees; subtract 180 degrees for directions from 270 through 360 degrees.

COMPUTATION OF TRUE WIND.—Once the apparent wind direction and speed have been observed and the ship's course and speed recorded, the true wind can be computed. There are three basic methods for computing the true wind. All three methods use the vectors of the apparent wind and ship's movement. These methods are: *true wind computer method*, *maneuvering board method*, and *plotting board method*. All three produce accurate computations. Since the true wind speed is reported to the nearest knot and the direction is reported to the nearest 10 degrees, accuracy is not a factor in choosing a preferable method. The true wind computer, CP 264/U, as seen in figure 1-3-29 is the quickest and easiest method and should be selected over the other two methods. The maneuvering board and plotting board methods are about equal in computation time and ease of use but plotting boards are not as available as maneuvering boards.

True Wind Computer Method.—The true wind computer consists of an oval base plate

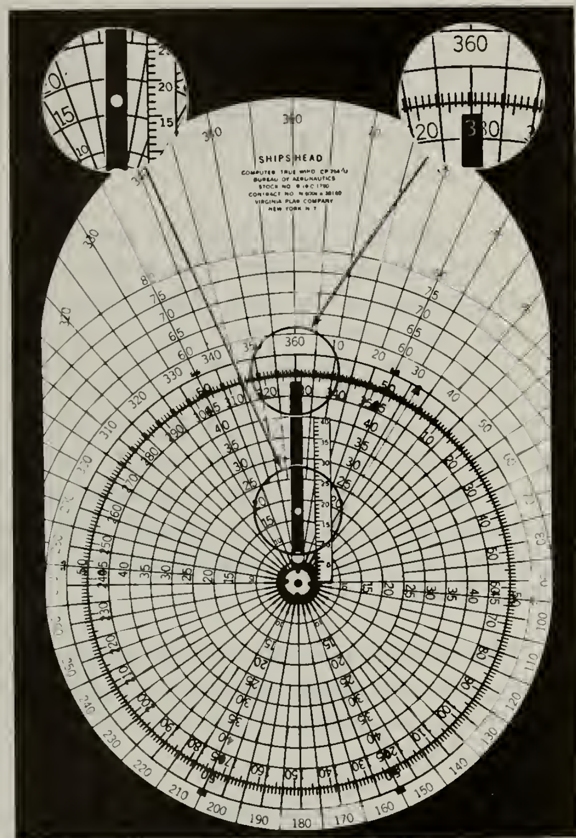

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Figure 1-3-29.—True wind computer CP-264/U.

and a clear plastic compass rose fastened with a center pivot. The compass rose is free to rotate and slide along the axis of the base plate. All computations are made directly on the computer, and solutions are read off of its scales. Directions for use are printed on the reverse side of the base plate.

1. An example of using the computer for determining the true wind direction and speed is given as follows. Assume that the apparent wind is 300 degrees and 18 knots, and the ship's course and speed are 080 degrees and 16 knots.

a. Slide the rotor disk along the ship's speed reference line until the center index of the rotor disk is opposite the ship's speed (16 knots); then rotate the disk until the ship's heading (080 degrees true on the compass rose of the rotor disk)

is directly over the 000/360 degree bearing radius of the base plate.

b. Plot with a grease pencil a dot on the rotor disk at the point determined by the apparent wind (300 degrees true and speed 18 knots), using the base grid.

c. Slide the rotor disk to the zero of the ship's speed reference index (the center of the concentric circles of the base plate); rotate the disk until the grease pencil dot (previously plotted) lies along the 000/360 degree bearing radius of the base plate. The true wind direction (328 degrees) can now be read directly off the rotor disk over the 000/360 degree bearing radius of the base plate. The true wind speed (17.5 knots) can now be read directly opposite the grease pencil dot by using the ship's speed reference index.

2. The computer is also used to determine a ship's course and speed required to produce a desired apparent wind. To do this follow the example below:

Assume that the desired wind direction is 5 degrees off the port bow and the desired wind speed is 40 knots, actual apparent wind is 300 degrees and 18 knots, present ship's course is 080 degrees true, and present ship's speed is 16 knots.

a. Repeat steps a, b, and c of the example in subparagraph 1 to find the true wind direction and speed of 328 degrees and 17.5 knots.

b. Manipulate the rotor disk (by rotation and sliding along the 000/360 degree bearing radius of the base plate) until the grease pencil dot, the head of the true wind vector, is directly over the reference point on the base plate as determined by the given requirements of the desired apparent wind (direction at 5 degrees off the port bow and speed of 40 knots across the deck), using the grid of the base plate.

c. Read directly off the rotor disk the ship's course (340 degrees true) which is directly over the 000/360 degree bearing radius of the base plate. Read directly the ship's speed (23.5 knots) opposite the center of the rotor disk from the ship's speed reference index. This ship's course (340 degrees true and a speed of 23.5 knots) with the given true wind direction and speed produces the desired apparent wind of 5 degrees off the port bow and a speed of 40 knots across the deck.

Maneuvering Board Method.—The maneuvering board is a form printed by the Naval Oceanographic Office (Form H.O. 2665-10 or Chart 5090). The board has many uses in navigation but is also used to compute the true wind when a true wind computer is not available. (See figure 1-3-30.)

1. There are two variations of this method. In both methods two steps must be performed first.

a. Draw the vector of the ship's course and speed (line segment e, r). Choose a distance scale at the bottom of the form, once a scale is chosen it must be used throughout the computation. Measure out on the scale a line segment representing the ship's speed (15 knots = 15 values on the scale). Label the center of the circle on the board point e. On the radius equaling the direction of the ship, start at point e and draw a line segment out representing the ship's speed. Label the end of the segment r.

b. Change the rotation of the apparent wind direction from the ship's bow to true north. Add the apparent wind direction to the ship's course. If the sum is greater than 360 degrees, subtract 360 from the sum.

2. The first variation consists of the following steps:

a. Take the apparent wind direction in relation to true north (see 1.b. above) and add 180 degrees. This changes the direction "from which the wind is blowing" to the direction "towards which the wind is blowing." If the sum is greater than 360 degrees, subtract 360 from the sum.

b. Take the maneuvering board with the ship's vector plotted in step 1.a. Using parallel

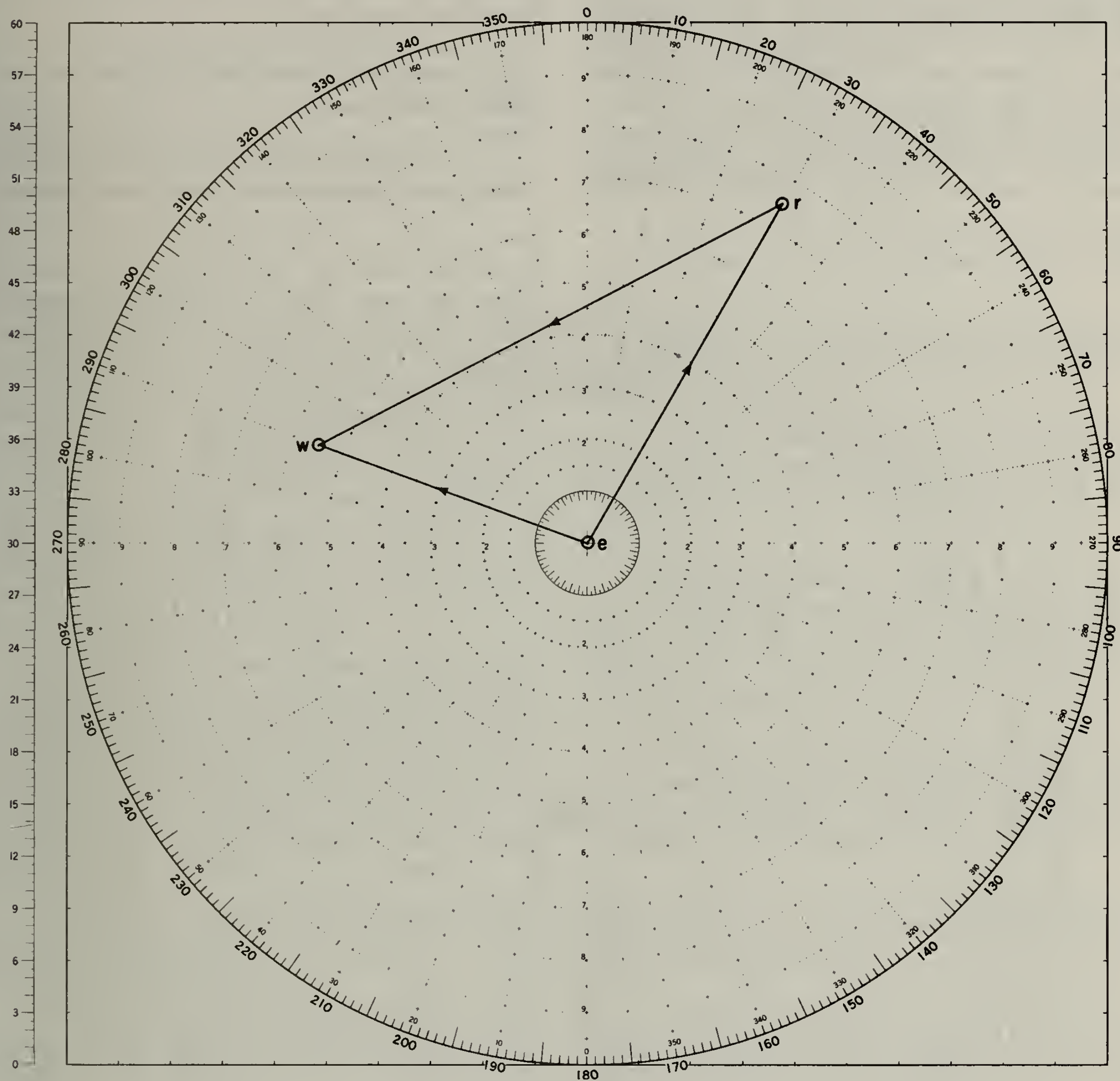

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Figure 1-3-30.—Maneuvering board.

rulers with one rule at point e and one at point r, set the rule at point e along the radius equaling the direction of the apparent wind as manipulated in paragraph 2.b. Measure out on the distance scale used in paragraph 1.a. the line segment representing the apparent wind speed. From point r draw a line segment equalling the wind speed along the parallel rule. Label the end of the line segment point w.

c. Line segments e-r and r-w form two sides of a triangle. Draw the third side of the

triangle, line segment e-w. This vector represents the true wind. To determine the true wind direction take the direction of the radius that line segment e-w lies along and add 180; if the sum is greater than 360 degrees, subtract 360 from the sum. This gives the direction from which the true wind is blowing. To determine the speed of the true wind, measure the length of line segment e-w and using the distance scale used previously, determine the value for the length of the line segment e-w. This value from the scale is the true wind speed.

3. The second variation consists of the following steps:

a. Take the maneuvering board with the ship's vector plotted in step 1.a. From the center

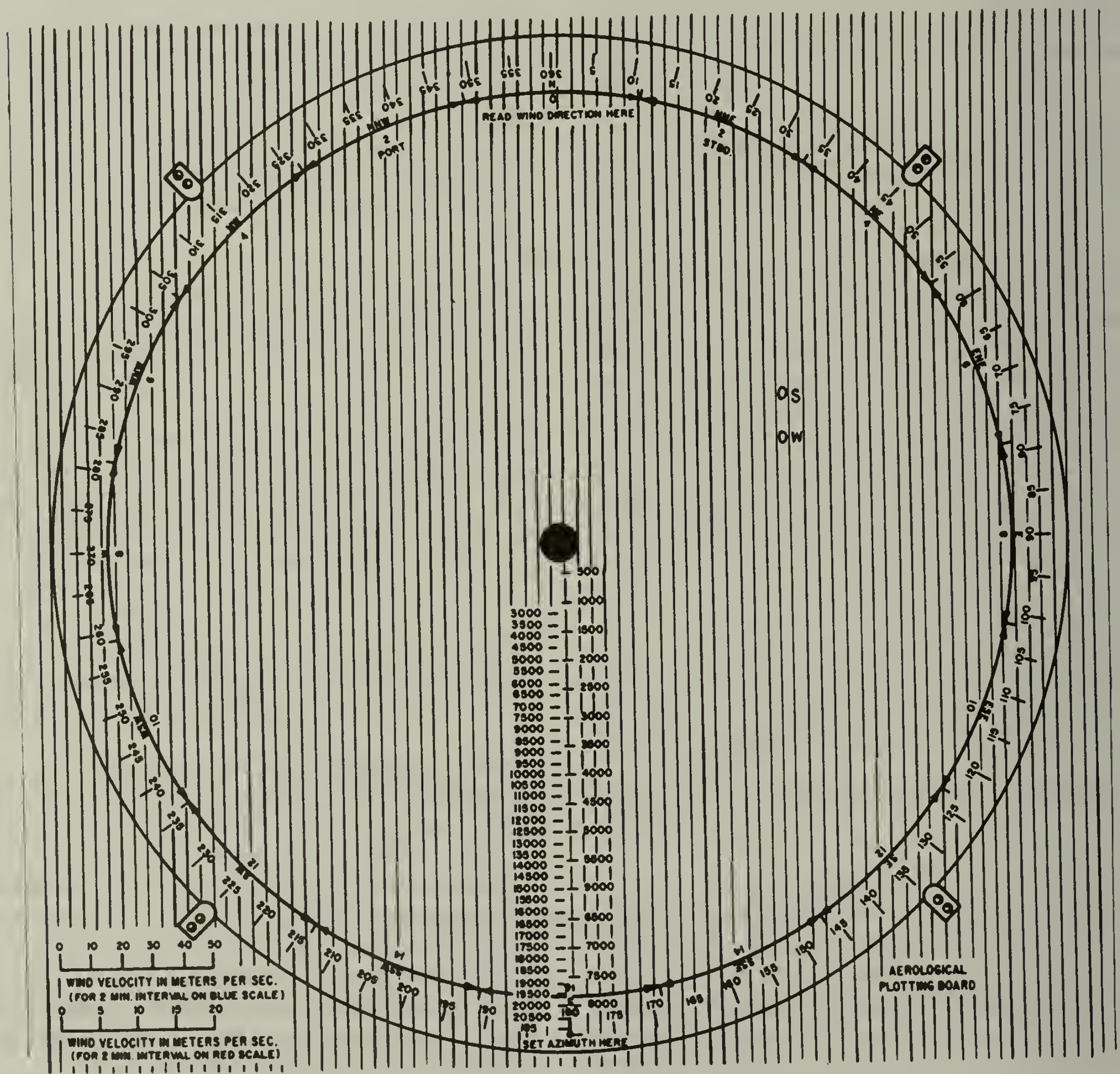

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Figure 1-3-31.—Plotting board.

point e extend a line out the radius equaling the apparent wind direction as manipulated in paragraph 1.b.

b. From the end of the ship's vector (line segment e-r) using parallel rulers draw a line segment equal to the apparent wind speed measured off the distance scale used in paragraph 1.a. parallel to the line drawn in a. above. Label the end of this line segment point w.

c. Line segments e-r and r-w form two sides of a triangle. Draw the third side of the triangle, line segment e-w. This vector represents the true wind. To determine the true wind direction take the direction of the radius that line segment e-w lies along and add 180; if the sum is greater than 360 degrees, subtract 360 from the sum. This gives the direction from which the true wind is blowing. To determine the speed of the true wind, measure the length of line segment e-w and using the distance scale used previously, determine the value for the length of the line segment e-w. This value from the scale is the true wind speed.

Plotting Board Method.—The plotting board method is similar to the maneuvering board method, but slightly more accurate (see figure 1-3-31). To compute the true wind follow the example below, assuming the ship's direction is 120 degrees and speed is 12 knots, and the apparent wind is from 110 degrees relative to the ship's bow at 15 knots.

1. Rotate the plastic disk until the ship's direction (120 degrees) is set opposite the pointer at the top of the board.

2. Place a dot representing the ship's speed (12 knots) 12 units down vertically from the center of the board and mark this point "ship."

3. Add the direction of the wind 110 degrees to the ship's course (120 degrees) to obtain a second disk setting of 230 degrees at the top of the board. If the sum is greater than 360 degrees, subtract 360 from the sum.

4. Place a dot representing the apparent wind speed (15 knots) 15 units down vertically from the center of the board.

5. Rotate the disk until the two dots are vertical with respect to the board with the ship data at the top.

6. Read the true wind direction opposite the pointer at the top of the board.

7. Measure the distance between the two dots with the same scale as used with the ship's speed and apparent wind speed to derive the true wind speed.

COMPUTATION CHECK.—No matter which method of computation is used to derive the true wind direction and speed, the observer should check the results by considering the following statements:

1. The true wind direction is always on the same side of the ship as the apparent wind direction but farther from the bow than the apparent wind direction.

2. When the apparent wind direction is abaft the beam, the true wind speed is greater than the apparent speed.

3. When the apparent wind direction is forward of the beam, the true wind speed is less than the apparent speed.

EXERCISE (1-3-9)

For items 1 through 5, read the information and fill in the missing words.

1. **On the AN/GMQ-29 the wind direction and wind speed are constantly updating every____________seconds.**

2. **AN/PMQ-3 hand anemometer can measure wind speeds up to ____________knots.**

3. **The shipboard wind system only records the____________wind direction and speed.**

4. **To use the true wind computer CP264/U, you must first determine the ____________wind direction and speed along with the____________ course and speed.**

5. **When a true wind computer CP264/U is not available, a____________ board or____________board may be used to compute wind direction and speed.**

FORMS

Before entering wind data information onto a surface observation form there are four qualities of the wind that the observer must determine. These qualities are wind direction, wind speed, character, and shifts. Instructions for determining these qualities of the wind are contained in the paragraphs that follow.

1. Wind direction is observed for a 1-minute interval with reference to true north and in 10 degree increments in a clockwise direction from true north. When the air is not in motion, the wind is said to be CALM. When instruments for measuring the wind direction are not available or are inoperative, estimate the direction by observing a wind cone or tee, movement of trees, smoke, or by facing into the wind in an unsheltered area.

NOTE: Do not use the movement of clouds (regardless of how low the clouds are) in estimating the surface wind direction.

2. Determine wind speed of the surface wind to the nearest knot. In general, observed wind speeds are a 1-MINUTE AVERAGE. So far as possible, the average wind speed observation should not be made during a peak or lull in gusty winds or squalls.

Where wind speed instruments are temporarily unrepresentative or not available, estimated speed (including gustiness and squall data) may be determined by use of Appendix VIII.

3. The character and shifts of the wind are determined by examining the wind speed indicator/recorder to determine if the required criteria have been met to report the phenomena.

CNOC 3140/7 Entries

Although the following descriptions of wind element entries are correct, they are brief and the aerographer should refer to the FMH-1B for a more complete and detailed description of the proper procedures.

WIND DIRECTION (COLUMN 9).—Enter the wind direction to the nearest tens of degrees. Use two digits as shown in table 1-3-4. Enter "00" when the wind is calm. Whenever either

Table 1-3-4.—Wind direction in tens of degrees

Degrees	Compass Points	Tens of degrees
355-004	N	36
005-014		01
015-024	NNE	02
025-034		03
035-044		04
045-054	NE	05
055-064		06
065-074	ENE	07
075-084		08
085-094	E	09
095-104		10
105-114	ESE	11
115-124		12
125-134		13
135-144	SE	14
145-154		15
155-164	SSE	16
165-174		17
175-184	S	18
185-194		19
195-204	SSW	20
205-214		21
215-224		22
225-234	SW	23
235-244		24
245-254	WSW	25
255-264		26
265-274	W	27
275-284		28
285-294	WNW	29
295-304		30
305-314		31
315-324	NW	32
325-334		33
335-344	NNW	34
345-354		35

the reported wind direction, speed, speed of gusts or squalls is estimated, prefix the direction with an "E". When the wind speed is 100 knots or more, add 50 to the coded wind direction.

WIND SPEED (COLUMN 10).—Enter the wind speed in knots. For calm wind enter "00". When the speed exceeds 99 knots, enter only the tens and units figures and add 50 to the wind direction in column 9; e.g., 112 knots from 270 degrees—7712.

WIND CHARACTER (COLUMN 11).—Enter gusts by using the symbol "G" followed immediately by the peak speed of gusts observed during the past 10 minutes. Report squalls by the symbol "Q" followed immediately by the peak squall wind observed during the past 10 minutes.

These are reported when they occur regardless of the type of wind equipment used. The following examples illustrate the entry of wind data (refer to table 1-3-5):

a. 010° true at 7 knots.

b. Calm wind.

c. 160° true at 23 knots, peak speed of gusts at 31 knots.

d. 360° true at 103 knots, peak speed of squalls at 124 knots.

e. 290° true at 8 knots, peak speed of gusts estimated at 15 knots.

f. Varying between 050° and 110° (with a mean of 080°) at 7 knots.

Table 1-3-5.—Entries on CNOC Form 3140/7

	WIND			ALSTG	REMARKS
	DRCTN (true) (9)	SPEED (knots) (10)	CHARACTER (knots) (11)	(inches) (12)	DESIRED ORDER OF ENT
a	01	07			
b	00	00			
c	16	23	G31		
d	86	03	Q124		
e	E29	08	G15		
f	08	07			WND 05V11

209.471

REMARKS (COLUMN 13).—A wind shift is always reported when it occurs. To report a wind shift, enter in column 13 the contraction "WSHFT" followed by the time the wind shift began in minutes past the hour using two digits (e.g., WSHFT 37). When the shift is reasonably certain to be associated with a frontal passage, include the contraction "FROPA" immediately after the time (e.g., WSHFT 37 FROPA). If the remark containing this data is not transmitted via longline teletype, the data will then be included in the REMARKS section of the next transmitted report to be sent via longline teletype.

When wind meets the criteria for variable wind, the contraction "WND" is entered in column 13 followed by the extremes of variability and separated by the letter "V" (e.g., WND 32V05).

When recorded wind speed having exceeded 25 knots since the last Record observation and this speed was not included in the body of a Special observation transmitted on longline teletype, enter in the Remarks column 13 "PK WND", the direction and time of occurrence (in minutes) in the next Record observation following its occurrence; e.g., PK WND 2728/03. If the speed occurred more than once, encode the first occurrence only. Omit the remark if the speed is included in the body of this Record observation.

WIND SUMMARY OF THE DAY (COLUMNS 71, 72, and 73).—Enter data for peak wind of the day only at stations having continuous instantaneous wind speed recorders. If the record for the day is incomplete, it may still be used if there are indications that the missing data did not include the peak wind. If the peak wind speed occurred twice during the day, enter the last occurrence on the first line for direction and time, and enter the first occurrence on the second line. Additional occurrences will be entered only if they are considered significant by the observer, by entering a remark in column 90; e.g., PK WND 22° 1630, 14° 0507.

Speed of Peak Wind (Column 71).—Enter the highest instantaneous speed recorded during the 24 hours ending at midnight, to the nearest whole knot.

Direction of Peak Wind (Column 72).—Enter the true direction of the peak wind, in tens of degrees. If the direction portion of the recorder is inoperative, estimate the true direction from entries in column 9 and enter to the eight points of the compass.

Time of Peak Wind (Column 73).—Enter the time of the peak wind to the nearest minute GMT.

CNOC 3140/8 Entries

WIND (COLUMNS 9, 10, 11, and 13).—Enter the TRUE wind direction, wind speed (in knots), wind shifts, gustiness, and squalls in accordance with instructions for columns 9, 10, and 11 of CNOC 3140/7.

The difference between land station wind observations and shipboard wind observations is that compensation must be made for the ship's heading and speed, and true wind direction and speed have to be computed; they cannot be observed directly.

When wind indicating or recording equipments are inoperative or unavailable, estimate wind speeds in accordance with criteria listed in Appendix VIII. This appendix may also be used to check computed wind speeds. Wind directions may be estimated by observing the direction of travel of sea waves. Remember that such directions are relative to the ship's heading, and they must be converted to true directions.

SHIP SYNOPTIC CODE.—Wind direction and speed are used in the Ship Synoptic code. This section is covered in more detail in a later lesson.

EXERCISE (1-3-10)

For the following items 1 through 8, read the information and fill in the missing words.

1. **To enter a wind direction and speed onto a surface observation form, you must observe the wind for a ____________-minute interval.**

2. **On CNOC 3140/7, wind direction is entered to the nearest ____________ of degrees.**

3. **On CNOC 3140/7, wind speed is entered to the nearest ____________ knot.**

4. **On CNOC 3140/7, in column 13 with a peak wind, entry is made when the speed exceeded ____________ knots.**

5. **On CNOC 3140/7, in columns 71, 72, and 73, the peak wind for the ____________ is entered.**

6. **Column 71 is entered to the nearest ____________ knot.**

7. **Column 72 is entered to the nearest ____________.**

8. **Column 73 the time is entered to the nearest minute ____________.**

UNIT 1—LESSON 4

TYPES OF SURFACE OBSERVATIONS

OVERVIEW

Identify and classify criteria and techniques used for: reporting record, special, and local observations; obtaining marine portions of surface observations; and recording pilot reports (PIREPS).

OUTLINE

Record Observations

Special Observations

Local Observations

Sea and Swell Observations

Pilot Reports

Up to this point you have learned the specifics of observing, identifying, and recording many individual elements. You have studied the mathematical operations involved in computing the observation. You have reviewed the use of various instruments and equipment that help you measure weather elements. You now need to correlate the observational data for preparation in the proper format.

We will be concerned with both airways and METAR code reports and the various types of observations used for each code. Airways observations are recorded on MF 1-10 (CNOC 3140/7) and METAR observations are recorded on MF 1-10 (CNOC 3140/11). For reference see foldouts 1-4-1 and 1-4-2 at the end of this lesson. The observations for both codes are very similar and we will examine the various ways that they may be recorded. The main difference between airways and METAR codes is that airways code is a domestic (US only) code whereas METAR is used in foreign countries.

Learning Objective: Identify and classify criteria and techniques used for: reporting record, special, and local observations; obtaining marine portions of surface observations; and recording pilot reports (PIREPS).

RECORD OBSERVATIONS

You learned how to enter the various elements of an observation from material in previous lessons of this unit. Now you will study the types of observations and coded format when certain observing criteria are met. We will answer such questions as, when should you take and record special observations and what columns on the MF 1-10 are used to encode the different types of observations.

Learning Objective: Given record observations in airways code and METAR code, identify the errors in each observation and given simulated data, encode the freezing level data.

AIRWAYS OBSERVATIONS

Record observations are frequently referred to as hourly, 3-hourly, and 6-hourly observations.

Record Reports

Record reports are scheduled for hourly transmission over longline communications circuits. Since the observation is transmitted on the hour, you should start each record observation before the hour, always allowing sufficient time to

encode and disseminate the observation over teletype. Usually, you should observe all elements of the observation within 15 minutes preceding the time of dissemination. This means that if you complete your record observation 2 to 15 minutes before the hour, no element should be observed more than 15 minutes before the actual time of the observation. Of course, this is also applicable to the elements you append to your observation, such as pilot reports and similar additions from other sources.

Column entries required for record observations are as follows:

1. Column 3, Sky Condition.
2. Column 4, Prevailing Visibility.
3. Column 5, Weather and Obstruction to Vision.
4. Column 7, Temperature.
5. Column 8, Dewpoint.
6. Column 9, Wind Direction.
7. Column 10, Wind Speed.
8. Column 11, Wind Character.
9. Column 12, Altimeter Setting.
10. Column 13, Appropriate Remarks.
    a. RVR.
    b. Surface based obscuring phenomena.
    c. Other remarks elaborating on preceding coded data.
        (1) Significant to air traffic control.
        (2) Significant to meteorologists.
    d. Supplementary coded data.
        (1) Freezing level data (if available).
        (2) Runway conditions.
        (3) Weather modifications (if available).

We will now examine the elements of airways code that have not been covered previously.

FREEZING LEVEL DATA.—All stations (where data is available) will include freezing level and icing data in the first record observation following receipt of the data. Icing data is reported only when icing is determined from variations in the ascension rate of the balloon. Enter the data using the appropriate format below:

1. RADAT UU (D)($h_ph_ph_p$)($h_ph_ph_p$)($h_ph_ph_p$) (/n).
2. RADAT ZERO.
3. RADAT MISG.
4. (RAICG HHMSL SNW.)

The individual elements and contractions are explained as follows:

1. RADAT. A contraction to indicate that freezing level data follows.

a. UU. Relative humidity (RH) to the nearest percent. Use the highest RH of any of the coded crossings of the 0 °C isotherm. If the highest RH occurs at two or more levels, select the lowest level. Encode UU as "00" when the RH is 100 percent. Encode UU as "20" when the RH is 20 percent or less. Encode UU as "//" when the sounding crossed the 0 °C isotherm and RH is missing.

b. (D). A letter designator L (lowest), M (middle), or H (highest) to identify the 0 °C isotherm crossing to which the UU corresponds. Omit when only one height value is coded.

c. ($h_ph_ph_p$). The height, in hundreds of feet above MSL, where the sounding crossed the 0 °C isotherm. For encoding, select a maximum of three levels according to the following requirements: (1) select the first crossing of the 0 °C isotherm after release, (2) select the highest crossing of the 0 °C isotherm, and (3) select the intermediate crossing. Where there are two or more intermediate levels, select the one with the highest RH. If two or more intermediate levels have the same RH, select the lower level. After selecting the levels, encode them in ascending order of height.

d. (/n). Indicate for the number of crossings of the 0 °C isotherm *other than* heights encoded. This element is omitted if all crossings are coded.

2. ZERO. Enter "ZERO" in place of the coded data when the entire sounding is colder than 0 °C.

3. MISG. Enter "MISG" in place of the coded data when the surface temperature is

warmer than 0 °C and the sounding terminated before reaching the 0 °C isotherm.

4. RAICG. A contraction to indicate that icing data follows. (Report only when icing is present.) Enter this data following the RADAT data.

a. HHMSL. Indicate the altitude of icing in hundreds of feet with the indicator MSL following the height (i.e., RAICG 12MSL indicates "icing above 1,200 feet mean sea-level").

b. SNW. Indicate the contraction "SNW" if the snow is causing a slow ascension rate (i.e., RAICG 15MSL SNW).

RUNWAY CONDITION.—Enter runway surface condition and the average runway condition reading for the active runway as provided by the operations duty officer or tower personnel.

The main concern is that you encode all significant remarks in accordance with FMH-1B.

3-Hourly Report

Hourly record observations combined with 3- and 6-hourly observations enable the pilots and forecasters outside of your area (customers of our weather service) to have an airways report for each hour of the day. The 3-hourly observations are recorded at 0300, 0900, 1500, and 2100 GMT. The 3-hourly observation is encoded the same as an hourly report, except that you must encode certain other supplementary coded data. These data are as follows:

1. A 3-hourly barometric change (app).
2. Cloud code group ($1C_LC_MC_H$ when clouds are present).

6-Hourly Report

The 6-hourly observation is the remaining type of record observation and is recorded at 0000, 0600, 1200, and 1800 GMT. This record observation type differs only in the coded data entries in column 13 on form MF 1-10. For a 6-hourly the entries included are:

1. A 3-hourly barometric change and the amount of 6 hours precipitation (appRR99ppp).
2. Cloud code group ($1C_LC_MC_H$ when clouds are present).
3. Snow has occurred (904spsp).
4. Maximum or minimum temperature (Tn/xTn/x when required).
5. A 24-hourly precipitation ($2R_{24}R_{24}R_{24}R_{24}$ at 1200 GMT only).

METAR OBSERVATIONS

Since you have already studied the many elements used to make an airways observation, you should not have any trouble in making a METAR observation. Only the method of reporting and disseminating is changed in some cases. You will notice the similarity between CNOC 3140/7 and CNOC 3140/11 of Meteorological Form 1-10 (only the location of the various columns is different).

Record Reports

Record reports are transmitted each hour over the longline teletype. The same general rules apply to METAR hourly observations. METAR column entries for record observation follow:

1. Column 9—Wind Direction.
2. Column 10—Wind Speed.
3. Column 11—Maximum Wind Speed.
4. Column 4—Visibility.
5. Column 5—Weather and Obstruction to Vision.
6. Column 3—Sky Condition.
7. Column 7—Air Temperature.
8. Column 8—Dewpoint Temperature.
9. Column 12—Altimeter Setting.
10. Column 13—Appropriate Remarks.

We will now examine the elements of METAR code that differ from airways and have not been covered previously in this unit.

WIND—dddff/f_mf_m.—Let's begin with wind measurement:

1. Wind direction (ddd). Obtain a *10-minute mean* direction for the period preceding the period of observation.

2. Wind speed (ff). Obtain a 10-minute mean speed for the period preceding the observation.

3. Maximum wind speed (f_mf_m). Obtain the maximum wind speed if 10 knots or more for

the 10-minute preceding period. Maximum wind speed must exceed the 10-minute mean by 5 knots or more to be recorded.

4. Calm. Calm will be reported 00000.
5. Variable. Variable direction reported as 999 followed by the speed.

TEMPERATURE (T'T').—Enter air temperature to nearest whole degree *Celsius* in two digits and temperature below 0° are preceded with an "M".

DEWPOINT TEMPERATURE ($T'_dT'_d$).—Entered the same way as the temperature.

ALTIMETER SETTING.—Enter to nearest hundredth of an inch in four digits.

REMARKS.—Desired order of entry is this:.

1. Ceiling height (when below 3,000 feet prefix M, E, or W; i.e., CIG M028 indicates "ceiling measured at 2,800 feet above ground level").
2. Remarks elaborating on preceding coded data.
3. Supplementary coded data.

EXERCISE (1-4-1)

NOTE: Information presented in the first three lessons of this unit must be combined to answer the following exercises.

1. Identify the errors for each airways observation given in this example.

CNOC 3140/7 REV.(10-79) 0108-LF-031-4037

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10) (ABRIDGED FORM FOR MILITARY USE) | LATITUDE | LONGITUDE | STATION ELEVATION (Hp) FEET (MSL) | TIME CONVERSION (LST to GMT) + -

	TYPE (1)	TIME (GMT) (2)	SKY CONDITION (3)	PVLG VSBY (miles) (4)	WEATHER AND OBSTNS TO VISION (5)	SEA LEVEL PRESS (mb) (6)	TEMP (°F) (7)	DEW-POINT (°F) (8)	WIND DRCTN (true) (9)	WIND SPEED (knots) (10)	WIND CHARACTER (knots) (11)	ALTSTG (inches) (12)
a	SA	0057	WOX	0	FR		38	38	33	05		2992
b	SA	0158	W5X	5/16	S+		30	30	34	10		2995
c	SA	0255	M7OVC	1/2	ZR		35	36	36	08		000
d	SA	0355	8 SCT M13 OVC	1	TRW		45	44	09	25	G52	001
e	SA	0456	8SCT M15BKN 49 OVC	3	TRW-							
	/				A+		52	50	14	18		3002
f	SA	0555	15 SCT 50 SCT	6								

2. Identify the errors for each METAR observation given in this example.

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10)
METAR (ABRIDGED FORM FOR MILITARY USE)

	TYPE (1)	TIME (GMT) (2)	WIND DRCTN (true) (5)	WIND SPEED (knots) (10)	WIND MAX WIND (knots) (11)	VISIBILITY PREVAILING MILES (4A)	VISIBILITY PREVAILING METERS (4B)	RUNWAY VISUAL RANGE LOCAL (feet or miles) (4C)	RUNWAY VISUAL RANGE LONG-LINE (meters) (4D)	WEATHER AND OBSTRUCTIONS TO VISION LOCAL (5A)
a	SA	0558	07	04		½	09			06 HZ
b	SA	0657	100	00		7	99			
c	SA	0759	100	14	18	6	99			
d	SA	0856	07	5		6	90			11MIFG
e	SA	0959	130	9	16	1	17			25 RESH

LONGITUDE | STATION ELEVATION MSL FEET MSL | TIME CONVERSION LST TO GMT | MAG TO TRUE Deg | DAY LST | MONTH

	SKY CONDITION (3)	TEMP (°C) (7)	DEW-POINT (°C) (8)	ALSTG (inches) (12)	REMARKS AND S... (All times GMT. D... Ceiling height, othe... data, coded additive... sonde data, runway ...)
a	5SC050	20	18	992	
b	2CU030 6SC050	32	19	977	CIG E050
c	3SC019	28	22	985	CIG NO
d	5SC030	20	18	996	CIG M030
e	SCU025	25	17	998	

3. Encode the appropriate freezing level data for the following information:

Height in feet sounding crossed the 0 °C isotherm	RH(%)
1,900	79
2,900	80
4,500	84
5,100	80
5,600	75

SPECIAL OBSERVATIONS

The FMH-1B lists the critera for taking special observations. We will give this criteria in the following objective. Additionally, you must know what meteorological situations are critical at your station. For example, as the observer you need to know the landing minima for your air station which is published in Department of Defense Flight Information Publications (DOD FLIPs).

Learning Objective: Given hypothetical changes in weather conditions, make the required entries on MF 1-10 (CNOC 3140/7 in airways code and CNOC 3140/11 in METAR code).

AIRWAYS CODE

Encoded special airways observations use the following MF 1-10 entries:

1. Column 2, Time (GMT).
2. Column 3, Sky Condition.
3. Column 4, Visibility.
4. Column 5, Weather and Obstructions to Vision (if applicable).
5. Column 9, Wind Direction.
6. Column 10, Wind Speed.
7. Column 11, Wind Character (if applicable).
8. Column 12, Altimeter Setting.
9. Column 13, Remarks:

   a. RVR.
   b. Obscuring Phenomena.
   c. Remarks pertaining to preceding coded elements.
   d. Runway condition.

Mandatory Criteria

To better understand the encoding of special observations, let's examine the mandatory criteria. Take a special observation following a break in the hourly observation schedule.

WIND AND WINDSHIFT.—Take a special observation when:

1. The average 1-minute wind speed suddenly increases to twice or more than the currently reported wind speed, and exceeds 25 knots.
2. The wind direction changes 45 degrees or more in less than 15 minutes and is associated with a frontal passage or is the result of other causes if considered operationally significant.

RUNWAY CONDITIONS.—As required.

MISCELLANEOUS.—Any other meteorological situation which, in the opinion of the observer, is critical to safety of inbound aircraft.

SINGLE ELEMENT SPECIALS.—Single element specials are authorized to be taken for: (altimeter setting need not be appended)

1. Runway visual range.
2. Tornadic activity.
3. Runway conditions.

CEILING AND SKY CONDITION.—Take a special observation for ceiling and sky when:

1. The ceiling forms below, decreases to less than, or, if below, increases to equal or exceed:

   a. 3,000 feet.
   b. 1,500 feet.
   c. 1,000 feet.
   d. 500 feet.
   e. All published landing minima, applicable to the airfield, listed in DOD FLIPs.

2. Clouds or obscuring phenomena aloft are present below:

   a. 1,000 feet and no layer aloft was reported below 1,000 feet in the preceding record of special observation.
   b. The highest published instrument landing minimum applicable to the airfield and no layer aloft was reported below this height in the previous record of special observation.

PREVAILING VISIBILITY.—Take a special observation when the prevailing visibility is

observed to decrease to less than, or, if below, increases to equal or exceed:

1. 3 miles.
2. 2 miles.
3. 1 1/2 miles.
4. 1 mile.
5. All published landing minima applicable to the airfield listed in DOD FLIPs.

RUNWAY VISUAL RANGE.—At stations where airfield minima are published in feet, the RVR applicable to touchdown for the active runway is observed to decrease to less than or, if below, to increase to equal or exceed:

1. 6,000 feet.
2. 4,000 feet.
3. 2,400 feet.

TORNADO, FUNNEL CLOUD, WATER-SPOUT.—Take a special when it:

1. Is observed.
2. Disappears from sight.
3. Occurred within the past hour according to an unofficial report and was not observed or recorded at the station.

THUNDERSTORM.—Take a special observation when it:

1. Begins (a special is not required for the beginning of a new thunderstorm if one is currently reported in progress at the station).
2. Increases in intensity.
3. Ends.

PRECIPITATION.—Take a special observation when:

1. Hail begins or ends.
2. Freezing precipitation begins, ends, or changes intensity.
3. Ice pellets begin, end, or change intensity.
4. Any other type of precipitation begins or ends. (Special not required for changes in type or for beginning of a new type of precipitation while one is in progress.)

METAR CODE

The FMH-1B lists criteria for taking special (METAR/SPECI) observations. The general rules apply for both airways and METAR specials. The following columns on CNOC 3140/11 are used for special observations:

1. Column 2, Time (GMT)
2. Column 9, Wind Direction.
3. Column 10, Wind Speed.
4. Column 11, Maximum Wind Speed.
5. Column 4, Prevailing Visibility and RVR.
6. Column 5, Present Weather.
7. Column 3, Sky Condition.
8. Column 12, Altimeter Setting.
9. Column 13, Remarks:

    a. Ceiling height.
    b. Remarks elaborating on preceding coded data.
    c. Supplementary coded data.

The METAR specials (METAR/SPECI) have the same mandatory criteria as airways specials.

EXERCISE (1-4-2)

NOTE: Information presented in the first three lessons of this unit must be used to answer the following exercises.

1. Encode the following observations in an airways code on foldout 1-4-1, appearing at the end of this lesson (CNOC 3140/7). (There will be no entries for temperature, dewpoint, and altimeter setting.)

a. SKY CONDITION: 7/10 CB and SC at 1,800 feet determined by RBC. The CB is southwest of the station moving northeast.

VISIBILITY: 7 miles to the northwest and southeast; 8 miles to the northeast and southwest.

ATMOSPHERIC PHENOMENA: None.

WIND: 200 degrees at 12 knots.

OBSERVATION COMPLETED: 1255L (central standard time).

b. SKY CONDITION: 7/10 CB and SC. The height has not been redetermined since 1255L. The CB is southwest of the station moving northeast.

VISIBILITY: 7 miles to the northwest and northeast; 6 miles to the southeast; 5 miles to the southwest.)

ATMOSPHERIC PHENOMENA: Thunder is heard from the CB to the southwest at 1317L (CST). Occasional flashes of lightning are visible in-cloud and from cloud to ground to the southwest.

WIND: 190 degrees at an average speed of 24 knots. There are peaks to 29 knots and lulls to 18 knots. At 1303L a peak wind occurred from 200 degrees at 31 knots.

c. SKY CONDITION: 8/10 CB and SC, the bases are at 1,700 feet determined by the rotating beam ceilometer (RBC). The CB is southwest moving northeast.

VISIBILITY: 7 miles to the northeast; 5 miles to the southeast; 2 miles to the southwest; 7 miles to the northwest.

ATMOSPHERIC PHENOMENA: Thunder was heard 5 minutes ago from the southwest. Occasional in cloud lightning is visible to the southwest. Light rainshowers began at 1322L.

WIND: 190 degrees at an average of 18 knots. Peaks to 22 knots and lulls to 14 knots were recorded in the last 10 minutes.

EXERCISE (1-4-2)—Continued

2. Encode the following observations in METAR code on foldout 1-4-2, appearing at the end of the lesson (CNOC 3140/11). (There will be no entries for temperature, dewpoint, or altimeter setting.)

   a. SKY CONDITION: 4/8 CB and 3/8 SC at 1,600 feet determined by RBC. The CB is overhead moving to the northeast.

      VISIBILITY: 5 miles to the northeast; 3 miles to the southeast; 1 1/2 miles to the southwest; 3 miles to the northwest.

      ATMOSPHERIC PHENOMENA: Thunder is heard overhead accompanied by frequent in-cloud lightning. Moderate rainshowers are occurring.

      WIND: 200 degrees at 15 knots.

      OBSERVATION COMPLETED: 1357L (central standard time).

   b. SKY CONDITION: 3/8 CB and 4/8 SC measured at 1,400 feet. The CB is overhead moving northeast.

      VISIBILITY: 4 miles to the northeast; 2 1/2 miles to the southeast; 1 mile to the southwest; 2 1/2 miles to the northwest.

      ATMOSPHERIC PHENOMENA: Thunder is heard overhead, but no lightning is observed. Hail begins to fall at the station at 1403L with a maximum of 3/4 inches. Moderate rainshowers are still occurring.

      WIND: 220 degrees at 21 knots with gusts to 26 knots.

   c. SKY CONDITIONS: 5/8 CB and 3/8 SC measured at 1,200 feet. The CB is overhead moving northeast.

      VISIBILITY: 4 miles to the northeast; 2 1/2 miles to the southeast; 1 mile to the southwest; 3 miles to the northwest.

      ATMOSPHERIC PHENOMENA: Frequent thunder is heard overhead, but no lightning is observed. Moderate rainshowers are still occurring. The hail ended at 1414L.

      WIND: 220 degrees at an average speed of 21 knots. The maximum wind in last 10 minutes was 24 knots.

LOCAL OBSERVATIONS

Local observations may be taken and recorded at any weather observing station. They are taken primarily to report changes in conditions that are significant to local operations, but that do not meet special criteria. Changes in conditions that meet both local and special criteria will be reported as a special observation. Local observations are recorded on all MF 1-10s.

Learning Objective: Given lists of observations on CNOC 3140/7 and CNOC 3140/11, determine the type of observation and the requirement for the observation.

AIRWAYS CODE

For locals taken and disseminated in support of aircraft operations, the contents of the observation include:

1. Time.
2. Sky Condition.
3. Prevailing Visibility.
4. Weather and Obstructions to Vision (when applicable).
5. Remarks, as appropriate.

A local should be taken immediately following notification or observance of an aircraft mishap (ACFT MISHAP) at or near the station. These observations consist of all elements normally included in a record observation, except sea-level pressure, and are identified in remarks as "(ACFT MISHAP)". The remark (ACFT MISHAP) is NOT disseminated locally or longline.

Criteria

Local observations are not required for in-flight emergencies. However, such in-flight emergencies should alert the observer to intensify the weather watch and to take and disseminate any observation that would be of help to the aircraft in distress. If the in-flight emergency results in an accident, the aircraft mishap local observation is required.

RUNWAY CONDITION.—A local will be taken following notification of a change of the runway in use. These locals need to be taken only when specifically requested by a supporting agency.

RVR.—Take a local for RVR whenever the criteria below are observed to occur:

1. Visibility conditions for reporting RVR are first observed to occur and when the conditions are first observed to no longer exist.
2. RVR is observed to decrease to less than or, if below, to increase to equal or exceed each RVR minima applicable to the runway in use (other than those requiring a Special).
3. RVR is first determined as unavailable (i.e., RVRNO) for the runway in use, and when it is first determined that a report is no longer applicable.

ALTIMETER SETTING.—Take a local for altimeter setting as required:

1. When necessary to meet local requirements, which are determined locally.
2. Upon request.
3. At a frequency not to exceed 35 minutes since last determination.

This observation may be taken and disseminated as a "single element" local.

LOCAL SIGNIFICANCE.—Take a local for any criteria established because of its significance to local operations. For example,

1. Altimeter setting to local air traffic control.
2. Special list of local criteria.

METEOROLOGICAL SIGNIFICANCE.—Take a local for any meteorological situation which, in the opinion of the observer, is significant to local operations.

METAR CODE

The requirement for locals in METAR code are the same as for airways code.

EXERCISE (1-4-3)

1. Determine the type and the requirement for each observation in this example.

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF 1-10)
(ABRIDGED FORM FOR MILITARY USE)

	TYPE (1)	TIME (GMT) (2)	SKY CONDITION (3)	PVLG VSBY (miles) (4)	WEATHER AND OBSTNS TO VISION (5)
a	RS	0057	WOX	0	F
b		0105	W3X	1/16	IP-F
c		0121	W2X	5/16	IP-F
d		0135	W3X	3/8	SIP-F
e		0145	W4X	1/4	S+F
f		0158	W5X	5/16	SF
g		0209	W3X	1/4	S-F
h		0214	-XM14VOVC	3/16	R-S-F
i		0230	-XM6VOVC	3/8	IP-F
j		0238	-XM7VOCV	1/4	IP-F
k		0248	M5OVC	3/8	ZR-F
l		0255	M7OVC	1/2	ZR-F
m		0310	M6OVC	1/2	RF
n		0318	M5 OVC	1/2	R-F
o		0329	E6BKN 12 OVC	1/2	GF
p		0339	6 SCT M12 OVC	3/4	GF
q		0346	5-SCT M10 OVC	7/8	RW-GF
r		0355	8SCT M13 OVC	1	TRW
s		0417	8-SCT M14 OVC	2	TRW-
t		0428	8-BKN M11 OVC	1 1/8	TRW+
u		0437	7 SCT M12 OVC	7/8	TRW A
v		0444	7 SCT M13 OVC	3/4	TRW+
w		0456	8 SCT M15 BKN 49 OVC	3	TRW-
x		0513	M15 BKN 45 OVC	5	RW-
y		0526	15 SCT E45 BKN	6	RW-
z		0540	15 SCT 45-BKN	7	RW-
aa		0545	15 SCT E50 BKN	7	
bb		0555	15 SCT 50 SCT	7	

2. Turn to foldout 1-4-3 at the end of this lesson and determine the type of each observation listed and the requirement for each observation.

SEA AND SWELL OBSERVATIONS

Whether in carrier flight operations, resupply at sea, antisubmarine warfare, amphibious landings, sea search and rescue, or ship routing, sea conditions at the place and time the operation is being conducted become vitally important. The success or failure of any operation being conducted in an ocean environment is greatly dependent upon the extent to which the operation is affected by the sea. Your observations of the sea conditions (sea and swell) must be accurate so that the forecaster can provide the best possible operational forecast.

Learning Objective: Match wave terms, CREST, TROUGH, PERIOD, AND HEIGHT, with a given diagram.

SEA-WAVES

Sea-waves are caused by the force imparted on the sea surface by wind. Without wind, there can be no general wave action (except for that caused by changes of a more physical nature such as earthquake, volcano or wake activity).

Height

Observing waves calls for a measurement of their direction, period, and height. In order for you to do this, you must identify three specific items of wave appearance. The "tops" of waves are *crests* (A in figure 1-4-1). The "bottoms" of waves are *troughs* (B in figure 1-4-1). The third item is *wave height*, the vertical distance between the level of the crest and the level of the trough in whole feet (figure 1-4-2).

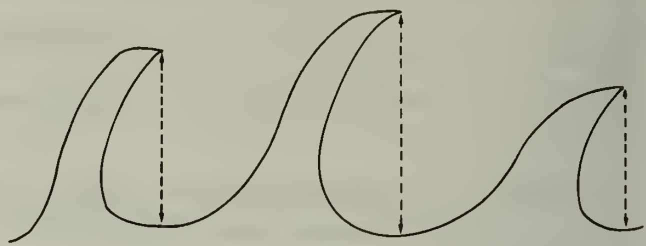


Figure 1-4-2.—Wave heights.

Period (T)

The wave *period* is the interval in seconds between the passage of two successive crests of well-formed waves past a fixed point. In figure 1-4-3, the wave period in seconds would be measured from A to C or from C to E.

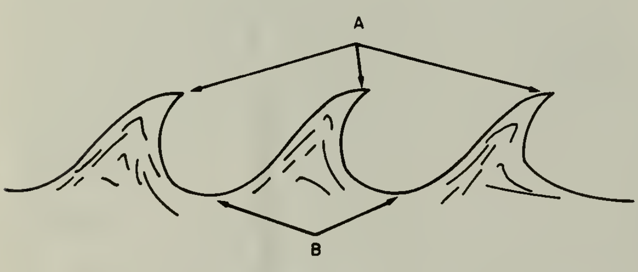


Figure 1-4-1.—Wave crests and troughs.

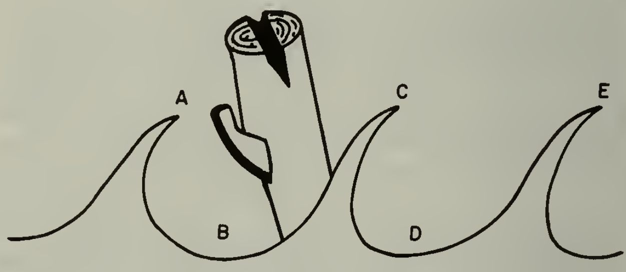
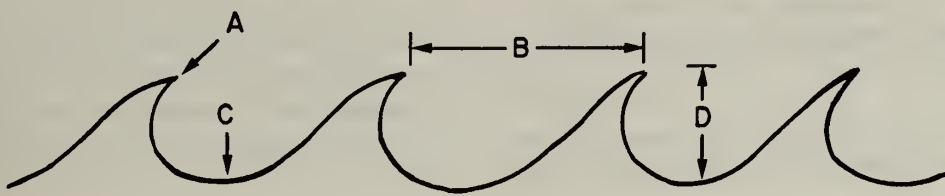


Figure 1-4-3.—Wave period.

EXERCISE (1-4-4)



1. **Match the letters of the wave diagram with the terms listed below it.**

   a. ____________ **Wave height.**

   b. ____________ **Wave crest.**

   c. ____________ **Wave period.**

   d. ____________ **Wave trough.**

Direction (D)

Learning Objective: State whether wave direction is defined as FROM or TOWARD the ship during an observation.

Wave direction, like wind direction, is the direction *from* which the waves are coming. This direction is determined with reference to true north. Wave direction may be determined by sighting along a wave crest (standing at a 90 degree angle to the wind direction). You'll be looking at a right angle to where it's coming *from*. Figure 1-4-4 shows the wave direction is north. Wave direction may also be determined by facing the oncoming crests (standing at 0° angle to the wind direction). Figure 1-4-5 shows the wave direction is east.

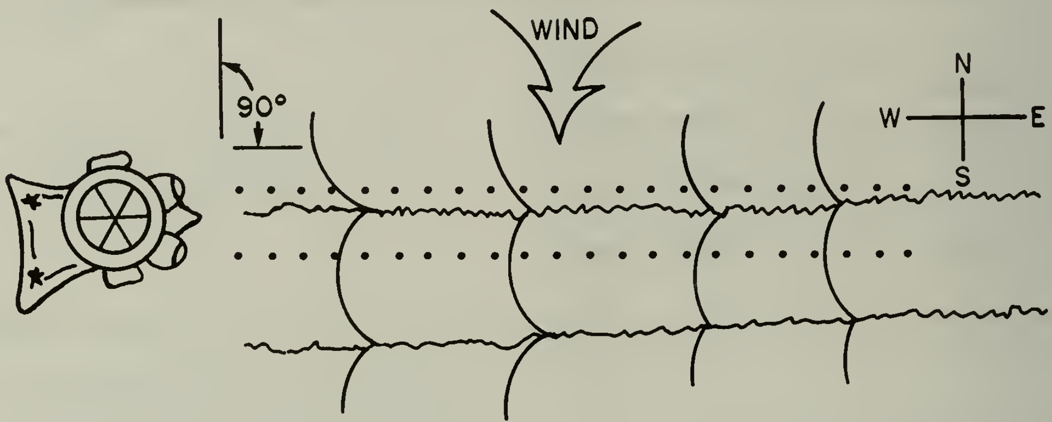


Figure 1-4-4.—Obtaining wave direction by sighting along a wave crest.

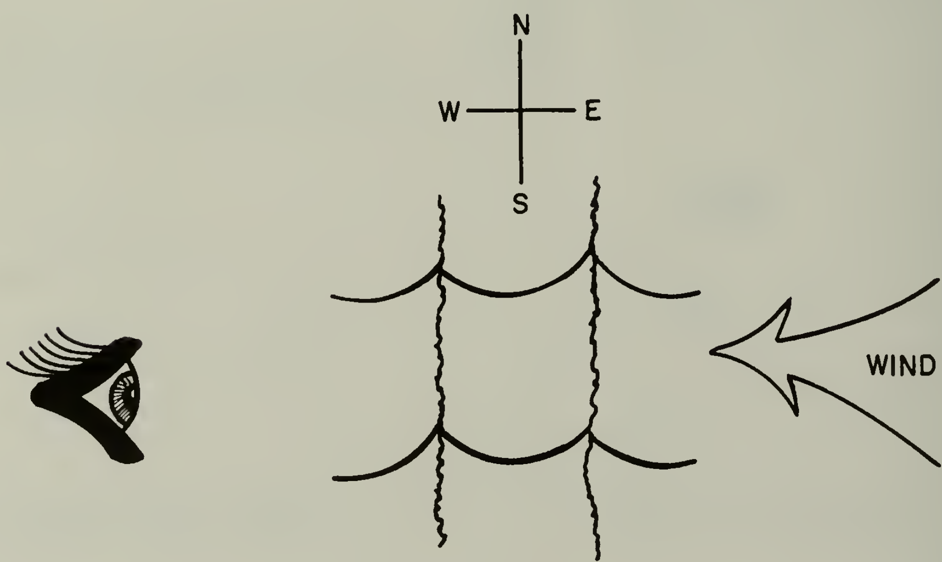


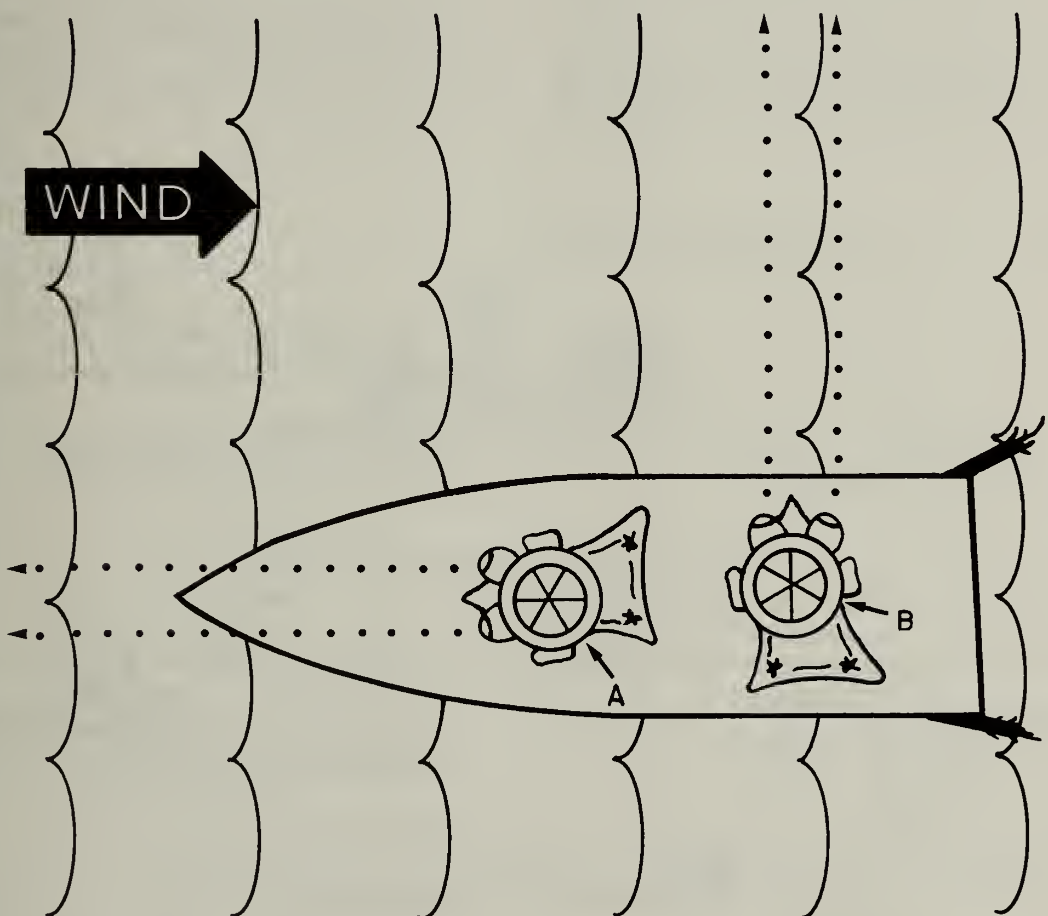
Figure 1-4-5.—Obtaining wave direction by facing the oncoming crests.

EXERCISE (1-4-5)

1. **You may stand in either of two positions relative to wave crests in order to determine wave direction. They are at a. ______________ degree angle and, b. ______________ degree angle to the wave crest.**

   In either case, the direction reported is the direction that the waves are moving c. ______________________________.

   d. In the diagram below which is the correct position for the observer to stand?



1. A only **2. B only** **3. A and B** **4. Neither A nor B**

(CIRCLE ONE.)

Wave Observation Procedures

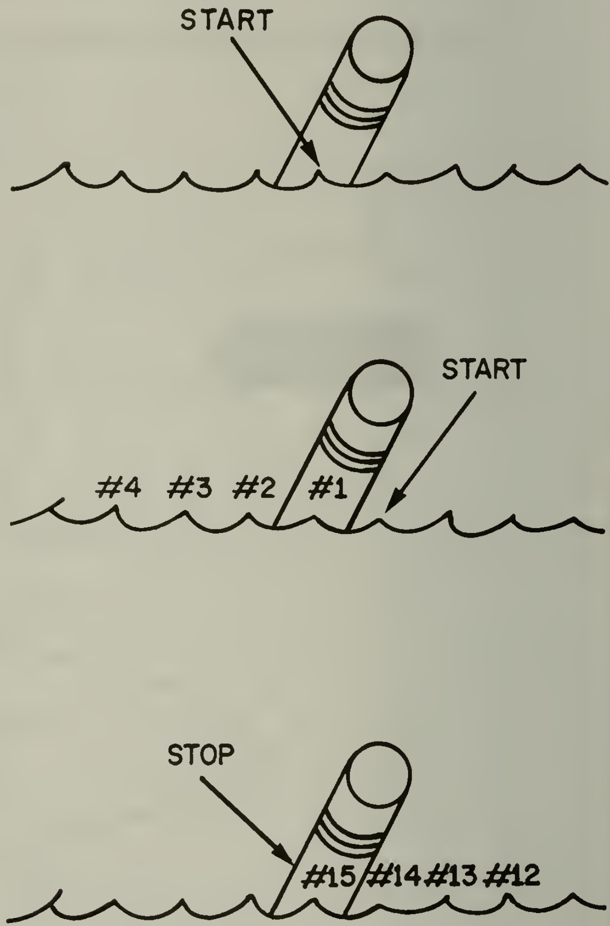
Learning Objective: Identify diagrams and complete statements regarding procedures for observing wave direction, period, and height.

OBSERVING WAVE PERIODS.—As was stated earlier wave period is determined by timing the interval (in seconds) for a series of wave crests to pass a fixed object. A buoy or another ship at anchor are good fixed reference points. Divide the time interval by the number of observed crests. (See figure 1-4-6.) If a fixed object is not in sight, try to select a distinctive patch of foam, a clump of seaweed or any other floating object at a

STEP 1 . . . Start the stop-watch.

STEP 2 . . . Count succeeding crests.

STEP 3 . . . Stop stop-watch.
(A number of at least 15 waves in a series is recommended.)



STEP 4 . . . Divide the time interval by the number of crests counted.

STEP 5 . . . Round off to the nearest whole second. = (T)

209.493

Figure 1-4-6.—Steps to determine wave period (T).

distance far enough so that its movement is not affected by the wake of yours or another ship. The marker you selected will bob up and down as the waves pass. Start the stopwatch when the mark is at the top of the wave; count succeeding times when the mark is at the top of a wave. After at least 15 waves have been counted, stop the watch at the last counted crest and compute the period to the nearest *whole second.* If neither of these two methods can be used, estimate the period as best you can by timing the passage of the crests past some part of your ship.

OBSERVING WAVE HEIGHT.—Wave height can best be determined using reference points such as the sides of your own or another ship in company or the horizon. When reading off sides of a ship, the draft markings near the stern can be used as a guide. Be sure NOT to read the bow-wave. (This is the wave formed by the ship's bow as it cuts through the water with the forward motion of the ship.)

When judging wave heights using the horizon, try to find a place as near to sea level as possible and where pitching of the ship is minimal, usually amidships (see figure 1-4-7). When the ship is in a trough and relatively level, judge the crest-height relative to the horizon. Observe as many wave heights as necessary and use an average of them, rounded off to the nearest *whole foot.* If you observe the wave heights from a high observation point (carrier flight deck), a wave height will look like A in figure 1-4-8. The same condition observed from a point near sea level (destroyer fan-tail) will look like B in figure 1-4-8. This is a form of the error of parallax and is the main reason wave heights tend to be overestimated when observed from small ships and under-estimated when observed from large ships.

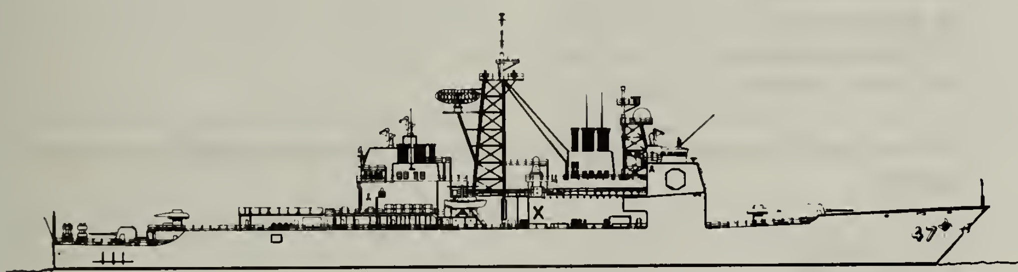


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Figure 1-4-7.—Shipboard observation point =X.

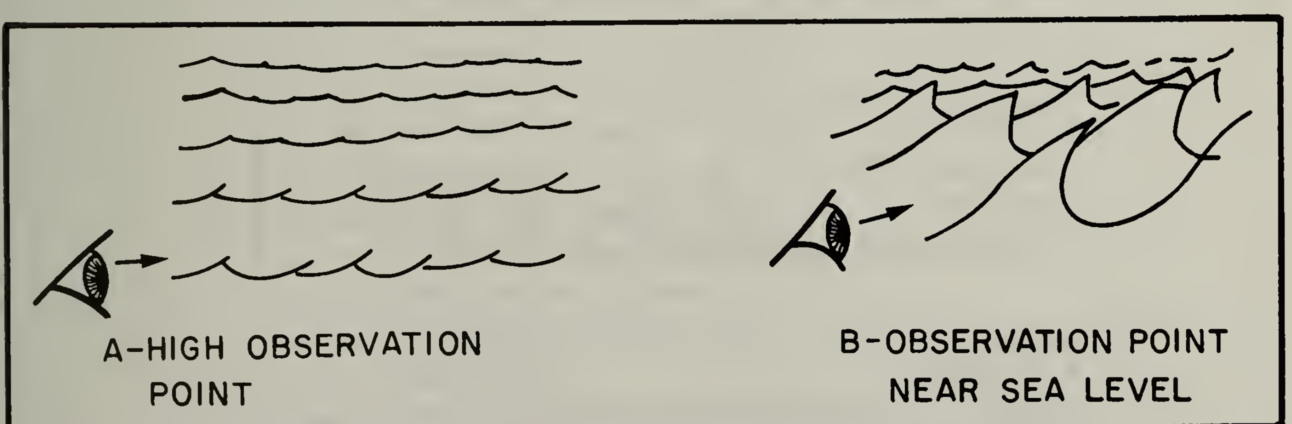

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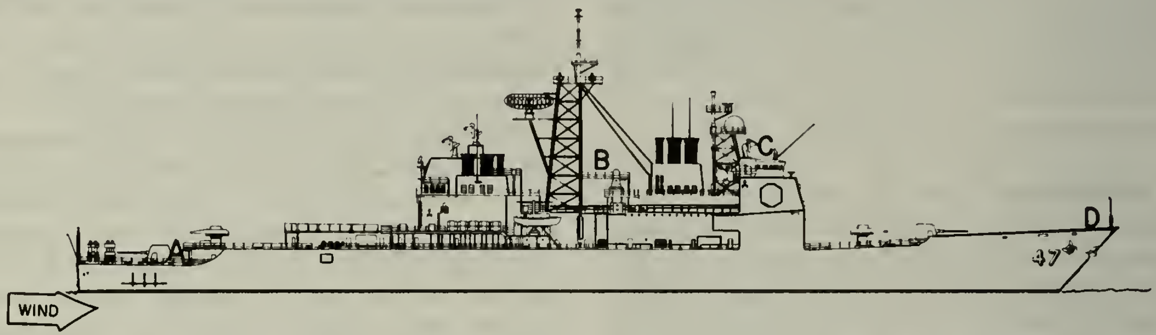
Figure 1-4-8.—Point of wave observation.

EXERCISE (1-4-6)

1. Where would you stand to take a wave-height observation on this ship?



A / B / C / D / (CIRCLE ONE)

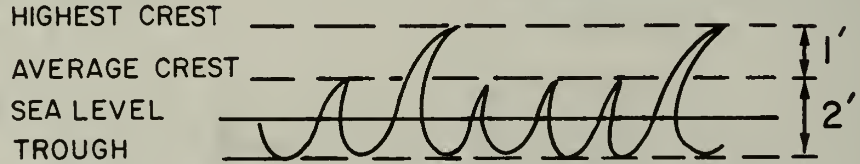
2. What is the sea-wave direction in the above diagram?

   A. From ahead
   B. From port
   C. From starboard
   D. From astern

3. If you count 26 sea-waves passing a piling in 2 minutes, what is the wave period?

   A. 4 seconds
   B. 5 seconds
   C. 8 seconds
   D. 12 seconds

4. How high is the highest wave in the diagram below?



   A. 2 ft.
   B. 2 1/2 ft.
   C. 3 ft.
   D. 4 ft.

Learning Objective: From a given list, select statements that describe sea-waves, and those that describe swell-waves.

SWELL-WAVES

There are two kinds of waves in the oceans. Sea-waves which are generated by the wind blowing in the local area and swell-waves which are generated by a wind blowing someplace else. Both have crests, troughs, heights, periods, and directions, but there usually is considerable difference in them. Look at the sea and swell patterns shown in figure 1-4-9 and note some of the differences.

Sea waves are usually short, "choppy" waves with distinct tops. They can range from ripples to phenomenal heights in excess of 45 feet.

On the other hand, swell-waves are long, undulating waves that will seem to "roll" under the ship, rather than "slap" against the side. They have a longer and more even period than sea-waves do.

Since sea-waves are waves created by local wind, their direction is assumed to be the same as the wind. Swell-waves are created outside your local area; therefore, their direction is often different from the sea-waves.

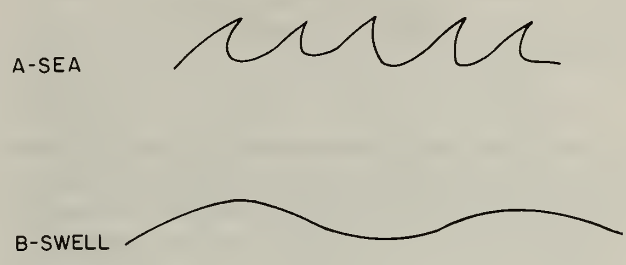


Figure 1-4-9.—Wave patterns.

NOTE: To qualify as a reportable swell-wave there must be at least 30 degrees difference in direction from the sea-wave.

Sometimes only a sea-wave exists. Sometimes only a swell-wave exists. Sometimes neither exists. Sometimes both exist. Combinations will exist such as sea-waves plus swells from two different directions. Since the wind can only blow from one direction at a time, only one sea-wave can exist at any one time.

EXERCISE (1-4-7)

If the characteristics below pertain to a sea-wave, put an "S" on the line preceding it. If they are characteristic to a swell-wave, write an "L". If they apply to both sea- and swell-waves, put an "S" and an "L".

1. ____________ **Generated in the local area.**
2. ____________ **Generated outside of the local area.**
3. ____________ **Short or "choppy".**
4. ____________ **Distinct crests.**
5. ____________ **Long and even period.**
6. ____________ **May exist without the other being present.**
7. ____________ **Only one can be present.**
8. ____________ **Long distance crest to crest.**
9. ____________ **Short period.**
10. ____________ **Direction always same as local wind.**
11. ____________ **Two or more may be present from different directions.**

PILOT WEATHER REPORTS (PIREPs)

Reports of weather conditions or meteorological phenomena encountered in flight by pilots are called PIREPs. These PIREPs become a valuable source of weather information. You can appreciate that satellite photos, computer readouts, and the resulting calculated forecasts are of keen interest to the forecaster who will brief pilots on weather conditions along their flight paths. However, nothing beats an "eyewitness report". These reports of cloud tops, wind, icing levels, etc., are invaluable to the pilot for planning and executing their flights. To ensure uniformity of reports NAVOCEANCOMINST 3140.10 Series covers the instructions for reporting, encoding, and transmitting PIREPs. The purpose of this section of the lesson is to introduce you to PIREPs and the form they are recorded on—DNOM Form 3140/10, foldout 1-4-4 (found at the end of this lesson).

RECORDING PIREPs

PIREPs received at Naval and Marine Corps weather activities will be recorded on the upper portion of DNOM Form 3140/10. Naval and Marine Corps weather activities in CONUS, Alaska, Guam, Hawaii and Puerto Rico will format the PIREP on the lower portion of DNOM Form 3140/10 for long line dissemination. In other areas, PIREPs will be retransmitted as received.

DISSEMINATION OF PIREPs

Local

The criteria, format, and procedures for local dissemination of PIREPs will be established locally.

Longline

All pilot weather reports containing information on the hazardous phenomena listed below will be disseminated via longline teletypewriter circuits as Severe Weather Reports (UUA).

1. Tornadoes, funnel clouds, and waterspouts
2. Severe or extreme turbulence or CAT (Clear Air Turbulence)
3. Hail
4. Severe icing

All post-flight or in-flight pilot weather reports from aircrews of overwater flights (except those considered local-area flights) will be disseminated over longline teletypewriter circuits IF:

1. Actual wind factors differ from wind factors forecast by 25 knots or more.
2. Significant enroute weather is reported and was not previously transmitted in-flight.

All other PIREPs will be evaluated by a forecaster (or an observer if no forecaster is on duty) to determine the need for longline transmission. Such PIREPs will be transmitted longline EXCEPT when the evaluation reveals any of the following:

1. Reports are duplicated; only the most recent one will be transmitted.
2. Reports contain only heights of cloud bases which are incorporated in the surface observation as outlined in FMH-1B.
3. Reports are substantially the same as data transmitted within the past 30 minutes.
4. Reports contain only negative occurrences and are outside the forecast area of such phenomena.

Learning Objective: Assemble and encode Pilot Weather Reports using standard codes and authorized contractions.

PIREP FORMAT

PIREPs, like hourly aviation observations, are encoded in a standard format using authorized contractions and location identifiers. Where

contractions are not applicable, use plain language. To transmit a PIREP longline, the message type, location, time of occurrence, and at least one other element are required. Elements which are not reported are omitted.

Domestic PIREP Longline Dissemination Format

The domestic PIREP format is composed of an indicator of message type and a series of text element indicators (TEIs). Each TEI consists of one solidus (/), two letters, and one space which identifies the element and tells the computer that data are forthcoming. The following is an explanation of the message types and TEIs:

MESSAGE TYPE (UUA/UA).—Indicator for a severe (UUA) or regular (UA) PIREP.

POSITION, TIME, AND ALTITUDE (/OV).—The position, time, and altitude sequence follows the PIREP format and that specified for position reporting in the DOD Flight Information Publication (FLIP) and Airman's Information Manual (AIM).

Position.—Each location will be reported using a three-letter location identifier of a navigational aid and, if necessary, a space and a six-digit group of numbers (the first three digits indicate the magnetic bearing from the location identifier and the last three digits indicate the nautical mile distance from the location identifier). Two or more locations may be grouped together by connecting each location with a hyphen, for example:

Pilot Reports location	Encoded as
Over NAS Alameda	NGZ
NAS Alameda to NAS Moffett Field	NGZ-NUQ
40 West of NAS Alameda to 10 North of NAS Moffett Field	NGZ 270040-NUQ 360010

Only three-letter location identifiers of navigational aids (excluding Nondirectional Beacons (NDB) and Instrument Landing Systems (ILS)) included in FAA Handbook 7350.4, Location Identifiers, may be used; i.e., locations of navigational aids such as TACANs, VORTACs, VORs, and TVORs. Accuracy (use of a compass, plotter, and dividers) is not required because the pilot/navigator may be estimating distance from a visible reporting point.

Time.—The GMT time of occurrence of the phenomena reported by the pilot, in four digits; e.g., 1642. If a period of time is reported, encode the midpoint; e.g., for 1854Z to 1926Z, encode 1910Z.

Altitude.—The flight altitude of the aircraft. This element is encoded using the contraction "FL," a space, and the altitude, in hundreds of feet to the nearest 100 feet above MSL, in three digits; e.g., FL 200. When altitude is unknown, encode as "FL UNK." The "FL" identifies this as an altitude to assist in manual interpretation and to flag computer programs.

TYPE AIRCRAFT (/TP).—The type of aircraft, if known, will be included in all PIREPs. Use the civil/military aircraft designators found in FAA Handbook 7340.1, Contractions. If the type aircraft is unknown, "UNK" will be reported.

SKY—CLOUD BASES AND TOPS (/SK).—The format for cloud, smoke, and haze layers is (1) height of base (if known), (2) sky cover contraction, and (3) height of top (if known). The heights of the bases and tops are reported in hundreds of feet above MSL, in three digits. Authorized contractions for reporting sky cover are CLR, SCT, THN-SCT, BKN, THN-BKN, OVC, THN-OVC, KLYR, THN-KLYR, HLYR, THN-HLYR. A space is required for clarity between the height of the bases reported and the sky cover contraction, and between the sky cover contraction and the height of tops; e.g., 030 BKN 045 or 025 THN-HLYR. If two or more layers are reported, each layer is separated by a solidus; e.g., 030 BKN 045/080 OVC. If the aircraft is in the clouds, "OVC" will be reported.

TEMPERATURE, AIR (/TA).—Temperature will be reported in whole degrees Celsius using two digits; e.g., 05. If a pilot reports temperature in degrees Fahrenheit, it must be converted to Celsius. Prefix negative temperatures with a minus sign (−).

WIND VELOCITY—DIRECTION AND SPEED (/WV).—Report wind direction and speed in three digits each; e.g., 270045. The intent is to include wind data for a particular point in time or winds measured over a very short leg of a flight. Accurate values, rather than rough estimates, are required. Estimated winds and wind components will be reported in the Remarks Section.

TURBULENCE—INTENSITY, TYPE AND ALTITUDE (/TB).

Intensity.—Intensity is the first element of turbulence reported following the TEI (/TB). The only observations/intensities that may be reported are NEG, LEGT, MDT, SVR, and EXTRM; include NEG in the TEI if reported in an area of forecast turbulence. Report varying intensity (e.g., moderate to severe) by inserting a hyphen (without spacing) to combine the intensities reported; e.g., MDT-SVR. A space follows the intensity or varying intensities at all times.

Type.—Include the type when clear air turbulence or CHOP is reported; e.g., LGT-MDT CAT. A space always follows CAT or CHOP; use CHOP when LGT and/or MDT intensity is reported. By definition, SVR or EXTRM CHOP is impossible.

Altitude.—Include the altitude (always reported in hundreds of feet, in three digits) immediately following the intensity of CAT unless the altitude reported is the same as the "FL" in the position TEI (in which case it will be omitted). A hyphen (without spacing) will be used to combine reported altitudes; e.g., 060-090. A layer with an undefined lower or upper limit will be reported as "BLO" or "ABV." The undefined values will be treated as an altitude; e.g., BLO-130 or 270-ABV. In this case, it is assumed that the pilot is still experiencing turbulence at the flight level reported in the position TEI. If this is not the case, report the top or base of the turbulent layer as a specific value. Reports of turbulence in colorful terms, e.g., "rougher than a cob," cannot be reported in this TEI. When a reportable term cannot be elicited, the forecaster/observer should use judgement to categorize the report (e.g., SVR, MDT-SVR, etc.) and include the pilot's assessed intensity in the Remarks element. Use a solidus to separate two or more layers of turbulence: e.g., LGT 060-140/MDT CAT 140-ABV.

ICING—INTENSITY, TYPE AND ALTITUDE (/IC).—The format in this TEI follows that used to report turbulence.

Intensity.—The only observations/intensities for reporting icing are: NEG, TRACE, LGT, MDT, and SVR. Include NEG in the TEI if reported in an area of forecast icing.

Type.—Icing will be reported as one of the following types: RIME, CLR (clear), or MXD (mixed).

Altitude.—Report the altitude (always reported in hundreds of feet, in three digits) in accordance with the instructions for reporting the altitude of turbulence layers. Use a solidus to separate two or more layers of icing; e.g., LGT RIME 010-045/070-100.

REMARKS (/RM).—This TEI permits the reporting of weather conditions not described elsewhere in the report or for clarifying previously reported elements. This TEI cannot be automatically scanned by the computer for specific items therein. Therefore, every effort should be made to classify reportable items in the preceding TEIs. Weather elements such as tornadoes, hail, thunderstorms, precipitation, obstructions to vision, etc., will immediately follow the TEI (/RM), with the most hazardous phenomenon listed first; e.g., /RM LN TSTMS E HIR CLDS VSB. This TEI can also be used to report wind components on a specific leg of a flight. If possible, include MH (magnetic heading), TAS (true airspeed), and the HEAD or TAIL (component of the wind).

Overseas PIREP Longline Dissemination Format

To prepare a PIREP for transmission report distances in nautical miles and heights in hundreds of feet above MSL. Report heights in three digits; e.g., 2,000 feet is encoded as 020. If a height is given above surface, and the mean sea level

equivalent cannot be determined, append AGL to the height; e.g., 017AGL.

STATION IDENTIFICATION.—Use the assigned ICAO identifier or other applicable station identification.

MESSAGE IDENTIFIER.—Enter the contraction PIREP.

TEXT OF MESSAGE.—Several pilot reports may be combined in the text of a PIREP message to avoid repetition of the station identifier, PIREP, etc. The data will be entered as follows:

Location and/or Extent.—Enter the location and/or extent of phenomena relative to an ICAO (International Civil Aviation Organization) four-letter identifier. For example, a PIREP received at Ramstein AB with a location given as over Kaiserslautern should be encoded as "8E EDAR." For overwater flights, when it is impractical to enter the location with reference to ICAO identifiers, enter the location in terms of whole degrees latitude and longitude followed by the aircraft reporting point, if known; e.g., 21N 160W MULLET.

Time.—The time, GMT, the phenomena were actually observed, if known.

Phenomena.—Insofar as is known, report data as follows for the following phenomena:

1. Clear Air Turbulence. Enter intensity, the contraction CAT, proximity of clouds, duration (if known), height of phenomenon, and type of aircraft. When no CAT is reported, use the contraction CAT NONE in the report.
2. Condensation Trails. Enter CONTRAILS followed by their height and type of aircraft.
3. Dust Storm or Sand Storm. Enter SA, height of aircraft, the horizontal visibility in the obscuration, and the height of the top of the obscuration, if known.
4. Electrical Discharge. Enter DISCHARGE followed by altitude and type of aircraft.
5. Smoke or Haze Layer. Enter FULYR or HZLYR followed by the height of the phenomenon and VIS followed by the horizontal visibility within the layer.
6. Hail. Enter the abbreviation GR followed by the height at which hail was encountered.
7. Icing. Enter intensity (TRACE, FBL, MOD, SEV), type (CLR, RIME, MX), the contraction ICE, the height at which icing is encountered, and the type of aircraft.
8. Lightning. Enter frequency (OCNL, FRQ) followed by LTGIC, LTGCC, LTGCG, LTGCA, as appropriate.
9. Sky Cover. Enter the appropriate sky cover contraction preceded by the height of the base and followed by the height of the top. Enter UNK if a sky cover amount is unknown. If the aircraft is in the clouds, enter INC and the height of the aircraft.
10. Tornado, Funnel Cloud, or Waterspout. Enter TORNADO, FUNNEL CLOUD, or WATERSPOUT (as appropriate), the direction of movement, the height and amount of parent cloud, and any information considered significant.
11. Turbulence (other than CAT). Enter intensity (FBL, MOD, SEV, EXTRM), followed by CHOP or TURB (whichever is reported), the height of the turbulence, and type of aircraft.
12. Wind. Use the contraction WND, the true direction to the nearest ten degrees and speed in knots (encoded as for METAR observations), followed by the height of the reported wind.

Type of Aircraft.—In reports of electrical discharge, contrails, turbulence, and icing, the type of aircraft is a required element of the report. If the type is unknown, enter ACFT UNK.

Other Elements of Operational Importance.—Any other element of meteorological or operational importance not mentioned above will be reported and clearly described using authorized contractions or plain language as necessary.

POST FLIGHT SUMMARIES.—Long post flight summaries may be encoded, without regard to format, provided the locations and extents of all elements are appropriately identified.

LANGUAGE AND TERMINOLOGY.—Some information may be reported in non-standard or unencodable descriptions; e.g., "very rough," "bumpy." The content of such reports should be transmitted as received, although contractions may be used.

Examples

The following example PIREPs provide illustrations of both the domestic and overseas text formats.

1. A pilot of a C9 cruising at 39,000 feet MSL reports to NAS Lakehurst that he encountered moderate clear air turbulence between 35,000 and 38,000 feet over Atlantic City, N.J. at 1700 EST.

DOMESTIC: NEL UA /OV ACY 2200 FL 390/TP C9/TB MDT CAT (MDT CHOP) 350-380

OVERSEAS: (KNEL) PIREP OVR (KACY) 2200 MOD CAT (OR CHOP) 350-380 C9

2. Dust Storm or Sand Storm. At 0510 GMT, a pilot reports to Dyess AFB that he is flying through a dust storm (or sand storm). He is 35 miles northeast of Dyess flying at 4,000 feet MSL with a visibility of 3/4 mile.

DOMESTIC: DYS UA /OV ABI 045035 0510 FL 040/TP UNK/RM DUSTSTORM (OR SANDSTORM) VSBY 3/4

OVERSEAS: (KDYS) PIREP 35NE (KDYS) 0510 SA VIS 3/4 040

3. A pilot reports a broken line of thunderstorms 45 miles northwest of NAS OCEANA in a north-south direction at 1624 EST. Bases are at 3,000 feet with tops at 34,500 feet. Occasional cloud-to-cloud and cloud-to-ground lightning are observed.

DOMESTIC: NTU UA /OV NTU 315045 2224 FL UNK/TP UNK/RM BKN LN TSTMS N-S OCNL LTGCCCG 030 UNK 345

OVERSEAS: (KNTU) PIREP 45NW (KNTU) 2224 BKN LN TS N-S OCNL LTGCCCG 030 UNK 345

EXERCISE (1-4-8)

Using the call signs from the previous examples, assemble and encode the following pilot weather reports:

1. The pilot of a DC-3 reports to NAS Lakehurst that he encountered broken clouds between 3,600 and 6,600 feet six miles southeast of Philadelphia (PNE/KPNE) at 1900 EST. At 7,000 feet he is between layers with an overcast deck above:

DOMESTIC: ______________________________

____

OVERSEAS: ______________________________

____

2. The pilot of a P-3A reports low-level wind shear after he lands at NAS Oceana. He landed at 0200Z and thinks the shear zone was at 1,500 feet MSL associated with light turbulence.

DOMESTIC: ______________________________

____

OVERSEAS: ______________________________

____

3. The pilot of a C-141 flying at 31,000 feet MSL over Dyess AFB reports light to moderate turbulence in clouds at 0223 GMT.

DOMESTIC: ______________________________

____

OVERSEAS: ______________________________

____

ONTH	YEAR	STATION AND STATE OR COUNTRY

EMENTARY CODED DATA based absc phenomena, remarks elaborating ng coded data 3-and 6-hourly additive data, data, runway conditions, weather modification (13)	STATION PRESSURE (inches) (17)	TOTAL SKY COVER (21)	OBS INIT (15)

ND MISCELLANEOUS PHENOMENA (90)

209.490

ION SURE (es) (7)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)

209.491

CNOC 3140/7 REV.(10-79) 0108-LF-031-4037

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10) (ABRIDGED FORM FOR MILITARY USE)	LATITUDE	LONGITUDE	STATION ELEVATION (H_p) FEET (MSL)	TIME CONVERSION LST to GMT) + − Hrs Hrs	MAG TO TRUE + − Deg Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

TYPE (1)	TIME (GMT) (2)	SKY CONDITION (3)	PVLG VSBY (miles) (4)	WEATHER AND OBSTNS TO VISION (5)	SEA LEVEL PRES (mb) (6)	TEMP (°F) (7)	DEW-POINT (°F) (8)	WIND ORCTN (true) (9)	WIND SPEED (knots) (10)	WIND CHARACTER (knots) (11)	ALSTG (inches) (12)	REMARKS AND SUPPLEMENTARY CODED DATA — DESIRED ORDER OF ENTRY: RVR, SFC based obsc phenomena, remarks elaborating on preceding coded data 3- and 6-hourly additive data, radiosonde data, runway conditions, weather modification (13)	STATION PRESSURE (inches) (17)	TOTAL SKY COVER (21)	OBS INIT (15)

SYNOPTIC DATA TIME (GMT) (41)	TIME (LST) (42)	NO. (43)	PRECIP (water equiv) (44)	SNOW FALL (45)	SNOW DEPTH (46)
Mid (LST) to:	Mid to:				
		(1)			
		(2)			
		(3)			
		(4)			
Mid (LST)	Mid (LST)				

STATION PRESSURE COMPUTATION					
TIME (GMT) (59)					
ATT THERM (60)					
OBSRVD BAR (61)					
TOTAL CORR (62)					
STA PRESS (63)					
BAROGRAPH (64)					
BARR CORR (65)					

SUMMARY OF THE DAY

24-HR MAX TEMP (°F) (66)	24-HR MIN TEMP (°F) (67)

PRECIP (water equiv) (68)	SNOW FALL (69)	SNOW DEPTH (70)

PEAK WIND

SPEED (knots) (71)	DRCTN (true) (72)	TIME (GMT) (73)

ACTIVE RNWY AND EQUIP CHANGE

TIME (GMT)	RNWY NO.	TIME (GMT)	RNWY NO.

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

209.490

1-4-27

30112101044177-004

FLD004000C0

Hrs Hrs	MAG TO TRUE + Deg − Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

ALSTG (inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA *(All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating precoding data, coded additive data group (if specified) radiosonde data, runway conditions, weather modification.)* (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

209.491

CNOC 3140/11 REV. (1–80) 0108–LF–031–4055

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10) METAR (ABRIDGED FORM FOR MILITARY USE)	LATITUDE	LONGITUDE	STATION ELEVATION (H_p) FEET (MSL)	TIME CONVERSION LST to + Hrs GMT) – Hrs	MAG TO TRUE + Deg – Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

TYPE (1)	TIME (GMT) (2)	WIND: DRCTN (true) (9)	WIND: SPEED (knots) (10)	WIND: MAX WIND (knots) (11)	VISIBILITY: PREVAILING: MILES (4A)	VISIBILITY: PREVAILING: METERS (4B)	VISIBILITY: RUNWAY VISUAL RANGE: LOCAL (feet or miles) (4C)	VISIBILITY: RUNWAY VISUAL RANGE: LONG-LINE (meters) (4D)	WEATHER AND OBSTRUCTIONS TO VISION: LOCAL (5A)	WEATHER AND OBSTRUCTIONS TO VISION: LONG-LINE (5B)	SKY CONDITION (3)	TEMP (°C) (7)	DEW-POINT (°C) (8)	ALSTG (inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating precoding data, coded additive data group (if specified) radio–sonde data, runway conditions, weather modification.) (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)

SYNOPTIC DATA

TIME (GMT) (41)	TIME (LST) (42)	NO. (43)	PRECIP (water equiv) (44)	SNOW FALL (45)	SNOW DEPTH (46)
Mid (LST) to:	Mid to:	X			X
		(1)			
		(2)			
		(3)			
		(4)			
Mid (LST)	Mid (LST)	X			

STATION PRESSURE COMPUTATION

TIME (GMT) (59)				
ATT THERM (60)				
OBSRVD BAR (61)				
TOTAL CORR (62)				
STA PRESS (63)				
BAROGRAPH (64)				
BARR CORR (65)				

SUMMARY OF THE DAY

24-HR MAX TEMP (°C) (66)	24-HR MIN TEMP (°C) (67)

PRECIP (water equiv) (68)	SNOW FALL (69)	SNOW DEPTH (70)

PEAK WIND

SPEED (knots) (71)	DRCTN (true) (72)	TIME (GMT) (73)

ACTIVE RNWY AND EQUIP CHANGE

TIME GMT	RNWY NO	TIME GMT	RNWY NO

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

209.491

Hrs / Hrs	MAG TO TRUE + Deg − Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

EW- INT C) (8)	ALSTG (inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating preceding data, coded additive data group (if specified) radiosonde data, runway conditions, weather modification.) (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)
5	2988	CIG080 CB SW MOV E TCU SW			7	HH
	2992	CIGM015 CB OVHD MOV NE PRESRR				HH
4	2993	CIGM015 OCNL CIGE006 OCNL				
		LTGCG SW CB ALQDS MOV NE	29.915		7	HH
	E2991	CIGM006 TS SW MOV NE OCNL				
		LTGCG CB ALQDS MOV NE				HH
	E2983	CIGM006 TS SW MOV NE FQT				
		LTGCCIC CB OVHD MOV NE PRESFR				HH
01	2984	CIG031 OCNL LTGIC CB NE MOV NE			8	HH
01	2985	CIG080 PKWND 3334/08			8	HH

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CNOC 3140/11 REV. (1—80) 0108—LF—031—4055

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10) METAR (ABRIDGED FORM FOR MILITARY USE)	LATITUDE	LONGITUDE	STATION ELEVATION (H_p) FEET (MSL)	TIME CONVERSION (LST to GMT) + Hrs − Hrs	MAG TO TRUE + Deg − Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

	TYPE (1)	TIME (GMT) (2)	WIND DRCTN (true) (9)	WIND SPEED (knots) (10)	WIND MAX WIND (knots) (11)	VISIBILITY PREVAILING MILES (4A)	VISIBILITY PREVAILING METERS (4B)	RUNWAY VISUAL RANGE LOCAL (feet or miles) (4C)	RUNWAY VISUAL RANGE LONG-LINE (meters) (4D)	WEATHER AND OBSTRUCTIONS TO VISION LOCAL (5A)	WEATHER AND OBSTRUCTIONS TO VISION LONG-LINE (5B)	SKY CONDITION (3)	TEMP (°C) (7)	DEW-POINT (°C) (8)	ALSTG (inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating precoding data, coded additive data group (if specified) radiosonde data, runway conditions, weather modification.) (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)
a	SA	0455	320	10		6	9000					1CB020 2CU020 4AC080	09	05	2988	CIG080 CB SW MOV E TCU SW			7	HH
b		0533	330	13		7	9999			RASH-	80RASH	1CU006 5CB015 3AC080			2992	CIGM015 CB OVHD MOV NE PRESRR				HH
c		0557	340			5	8000			RASH-	80RASH	4CU006 3CB015	08	04	2993	CIGM015 OCNL CIGE006 OCNL				
																LTGCG SW CB ALQDS MOV NE	29.915		7	HH
d		0610	350	18	25	4	6000			TS RASH-	95TS	5CU006 8CB015			E2991	CIGM006 TS SW MOV NE OCNL				
																LTGCG CB ALQDS MOV NE				HH
e		0635	340	38	52	2	3200			TS+ RASH	97TS	6CU006 2CB015			E2983	CIGM006 TS SW MOV NE FQT				
																LTGCCIC CB OVHD MOV NE PRESFR				HH
f		0658	350	35	41	4	6000			RASH-FG	91RA	3CU003 3CB031 2AC070	05	M01	2984	CIG031 OCNL LTGIC CB NE MOV NE			8	HH
g		0757	330	15		7	9999				25RESH	3CU030 8AC080	05	M01	2985	CIG080 PK WND 3334/08			8	HH

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PIREP	1. DATE/TIME PIREP RECEIVED (Z)
2. LOCATION OR EXTENT OF PHENOMENA	3. TIME OBSERVED (Z)
4. PHENOMENA AND ALTITUDE	
	5. AIRCRAFT TYPE

Legend: → = SPACE SYMBOL * = ONLY IF DIFFERENT FROM FL ** = ONLY IF CAT IS REPORTED

(U) UA →/OV→ → →FL → /TP→

MSG TYPE	LOCATION OF PHENOMENA 3—LTR IDENT RADIAL/DISTANCE	TIME(Z)	FLT LVL	TYPE ACFT

/SK→ /TA →

CLOUD	BASE AMOUNT TOP/BASE AMOUNT TOP/ETC.	TEMPERATURE °C

/WV → /TB→ /IC→

WIND (DIRECTION SPEED)	TURBULENCE INTENSITY TYPE** ALTITUDE*	ICING INTENSITY TYPE ALTITUDE*

/RM →

REMARKS PLAIN TEXT *(most hazardous element entered first)*

6. EVALUATION FOR DISSEMINATION *(For A, B, and C "X" as appropriate.)*			D. INITIALS	
A. LOCAL DISSEMINATION ☐	B. LONGLINE DISSEMINATION ☐	C. FOR USE IN SURFACE OBSERVATION ☐	FCSTR	OBSVR

NOM 3140/10 (REV 9-76) S/N 0108-LF-031-4050 PILOT REPORT

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UNIT 2

MISCELLANEOUS OBSERVATIONS

FOREWORD

Unit One gave you background knowledge on how to observe, record, and transmit Surface Observations. This unit presents knowledge on other observations you may be called on to perform.

This unit consists of three lessons. Lesson 1 covers the Surf Observation Report (*SUROB*) form and how to fill it out. Lesson 2 discusses *upper air* observations. Lesson 3 deals with the procedures and background for reporting winds aloft *observations*.

UNIT 2—LESSON 1

SURF OBSERVATIONS

OVERVIEW

Recognize the principles and procedures used for observing and reporting surf conditions.

OUTLINE

Basic steps

SURF OBSERVATIONS

Surf observation reports (SUROB) for a particular beach or point along a coastline provide critical information for the landing of personnel and equipment when small landing crafts and amphibious vehicles are used in enemy held territory. Surf condition along a beach is dependent on many factors such as exposure, sand bars, depth and inclination of the surf zone, etc., which may be hazardous for small craft operation. The safety and success of amphibious landings are largely dependent on known surf conditions. Surf conditions are observed and reported by various personnel involved in amphibious operations including personnel in the AG rating. It is of utmost importance that a SUROB be observed and reported in a timely manner.

Learning Objective: Identify different surf conditions, perform related computations, and prepare surf observation reports (SUROB).

A SUROB consists of the following information:

- Report (message) heading
- Significant breaker height
- Maximum breaker height
- Breaker period
- Breaker types
- Angle of breakers relative to beach
- Direction and speed of littoral (longshore) current
- Number of breaker lines
- Width of surf zone
- Remarks

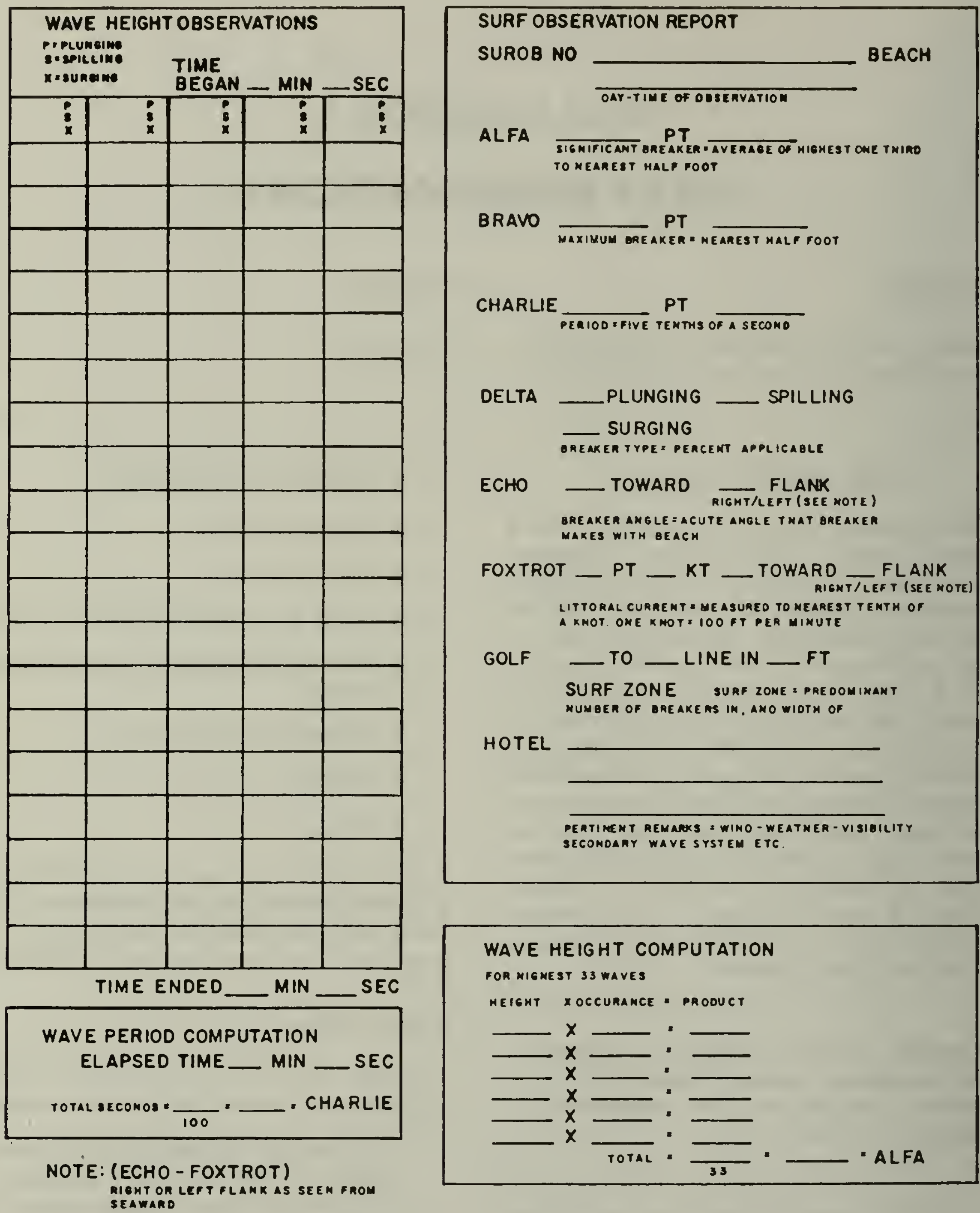
The information included in a SUROB message is ordered precisely as indicated above. To assist the observer in taking an observation, a worksheet, such as the one shown in figure 2-1-1 is used.

BASIC STEPS

There are three basic steps involved in reporting surf observations. These are as follows:

1. Recording the heights, types, and time lapse of 100 consecutive breakers
2. Performing simple mathematical computations
3. Compiling the SUROB report.

All three of these steps are performed on a single worksheet.



WAVE HEIGHT OBSERVATIONS
P=PLUNGING
S=SPILLING
X=SURGING
TIME BEGAN ___ MIN ___ SEC

P S X	P S X	P S X	P S X	P S X

TIME ENDED ___ MIN ___ SEC

WAVE PERIOD COMPUTATION
ELAPSED TIME ___ MIN ___ SEC
TOTAL SECONDS = ___ / 100 = ___ = CHARLIE

NOTE: (ECHO - FOXTROT)
RIGHT OR LEFT FLANK AS SEEN FROM SEAWARD

SURF OBSERVATION REPORT
SUROB NO ___________ BEACH
____
DAY-TIME OF OBSERVATION

ALFA ______ PT ______
SIGNIFICANT BREAKER = AVERAGE OF HIGHEST ONE THIRD TO NEAREST HALF FOOT

BRAVO ______ PT ______
MAXIMUM BREAKER = NEAREST HALF FOOT

CHARLIE ______ PT ______
PERIOD = FIVE TENTHS OF A SECOND

DELTA ___ PLUNGING ___ SPILLING ___ SURGING
BREAKER TYPE = PERCENT APPLICABLE

ECHO ___ TOWARD ___ FLANK
RIGHT/LEFT (SEE NOTE)
BREAKER ANGLE = ACUTE ANGLE THAT BREAKER MAKES WITH BEACH

FOXTROT ___ PT ___ KT ___ TOWARD ___ FLANK
RIGHT/LEFT (SEE NOTE)
LITTORAL CURRENT = MEASURED TO NEAREST TENTH OF A KNOT. ONE KNOT = 100 FT PER MINUTE

GOLF ___ TO ___ LINE IN ___ FT
SURF ZONE
SURF ZONE = PREDOMINANT NUMBER OF BREAKERS IN, AND WIDTH OF

HOTEL ___________
____
____
PERTINENT REMARKS = WIND - WEATHER - VISIBILITY SECONDARY WAVE SYSTEM ETC.

WAVE HEIGHT COMPUTATION
FOR HIGHEST 33 WAVES

HEIGHT	X OCCURANCE	= PRODUCT
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___

TOTAL = ___ / 33 = ___ = ALFA

Figure 2-1-1.—SUROB worksheet.

SURF OBSERVATION REPORT

SUROB NO ____________________ BEACH

____
DAY-TIME OF OBSERVATION

Figure 2-1-2.—SUROB heading.

Report Heading

The report or message heading of a surf observation consists of the contraction SUROB, the sequential number of the observation, the beach name, and the date and time of the observation, in that order. The SUROB number is always spelled out, the beach name may be either the actual or an assigned name, and the date-time of the observation is in local time. The heading of a surf observation report is shown in figure 2-1-2.

Wave Height Observations

Wave height observations are necessary before the code groups ALFA through DELTA are filled in. To do this, observe one hundred successive breakers and enter the type and estimated height in the 100 spaces provided on the WAVE HEIGHT OBSERVATIONS portion of the worksheet (shown in figure 2-1-3).

WAVE HEIGHT OBSERVATIONS

P=PLUNGING
S=SPILLING
X=SURGING

TIME BEGAN ___ MIN ___ SEC

P S X	P S X	P S X	P S X	P S X

TIME ENDED ___ MIN ___ SEC

Figure 2-1-3.—Wave height observations.

Breakers

As a deep water wave approaches a beach, it begins to peak up as it "feels bottom" and continues to increase in height until it breaks. Never estimate the height of a wave offshore and then assume that the breaker height will be the same. Breakers are usually larger than waves at a distance away from the breaking point. One method of estimating the height of breakers visually and without mechanical or optical aids is to adjust your position vertically so that your line of sight corresponds with an imaginary line from the top of a breaker to the horizon (see figure 2-1-4). The vertical distance from this line to the lower limit of the *backwash* is the approximate height of the breaker. This system becomes progressively less accurate as the distance between the observer and the breakers increase. While determining the height of the breaker, the observer must also determine the type of breaker. Perhaps the most important difference between breakers of similar height is the overall manner in which the breaking takes place; that is, whether the breakers are plunging, spilling, or of an intermediate type.

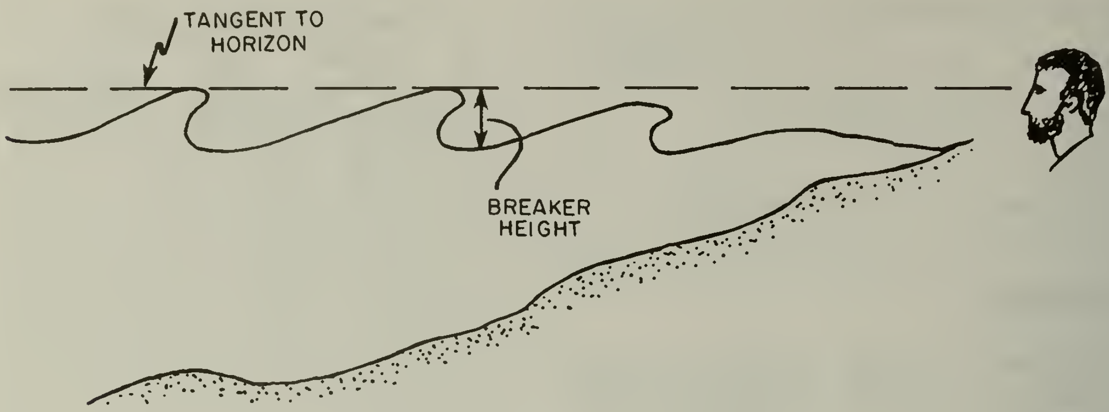


Figure 2-1-4.—Estimating the height of breakers.

SPILLING BREAKERS.—In a spilling breaker, the breaking process takes place over a considerable length of time and over a considerable part of the breaker in its travel towards the beach. The spilling breaker is characterized by a breaking process wherein the wave peaks up until it is very steep but not vertical. Only the topmost portion of the crest curls over and descends on the forward slope of the advancing wave where it then slides down into the trough. This process starts at scattered points along the wave, which then join together until the wave becomes an advancing line of foam.

PLUNGING BREAKERS.—In plunging breakers, the energy which the wave has transported across many miles of sea is released suddenly into a downward directed mass of water and is dissipated into heat by turbulence. The wave peaks up until it is an advancing vertical wall of water. The crest then curls far over and descends violently into the preceding trough where the water surface is essentially horizontal. Considerable air is trapped in this process and this air escapes explosively behind the wave, throwing water high above the surface. The plunging breaker is characterized by a loud explosive sound and can often be ascertained when it is not visible because of darkness or fog.

SURGING BREAKERS.—Surging breakers are less frequently observed than either spilling or plunging breakers. In breaking action of surging breakers, the wave crest tends to advance faster than the base of the wave to suggest the formation of a plunging breaker. However, the wave then advances faster than the crest, the plunging is arrested, and the breaker surges up the beach face as a wall of water which may or may not be *white water*.

RECORDING BREAKER TYPE.—To enter the type of breaker on the WAVE HEIGHT OBSERVATIONS portion of the worksheet, the code letters "p," "s," and "x" are used. The "p" is used for plunging breakers, "s" is used for spilling breakers, and "x" is used for surging breakers. If the first observed wave is estimated at three and one-half feet, and it is a spilling breaker, it would be entered as 3.5s. A six-foot plunging breaker would be entered as 6.0p, etc. It was mentioned earlier that it is necessary to observe 100 successive breakers and to record their heights and types on the worksheet. Adequate spaces are allotted on the upper left side of the worksheet for this purpose, WAVE HEIGHT OBSERVATIONS, shown in figure 2-1-3. It is also very important that the observer note the starting and ending time to the nearest second of the breaker observation so that the total time consumed observing the 100 successive breakers may be precisely determined.

ALFA

The code ALFA is the prefix for the significant breaker height, which is the average of the

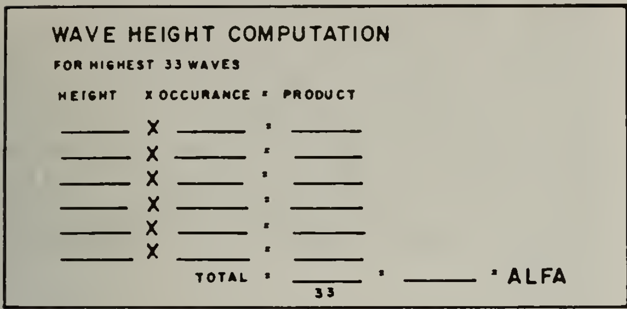


Figure 2-1-5.—Wave height computation block.

highest one-third (33 out of 100 observed) of the breakers, and is reported to the nearest one-half foot. To compute this, the worksheet has a wave height computation block (figure 2-1-5). To compute ALFA, you, as the observer, look through your wave height observations and find the highest breaker and the number of times it occurs. After recording this information in the WAVE HEIGHT COMPUTATION block, you then find the next highest breaker and the number of times it occurs, etc., up to a total of 33 waves. The next step is to multiply each height by the number of times it occurs, and then add the products together and enter the sum in the "TOTAL" entry space. The final step for computing ALFA is to divide the summation total of all the products by 33. To enter ALFA on the report, round off the final numerical value to the nearest half foot, and enter the derived value in the blocks provided.

NOTE: The "PT" as used in ALFA, BRAVO, CHARLIE, and FOXTROT is the abbreviation for the word "point" (decimal point).

BRAVO

The code BRAVO is the prefix for the highest breaker observed. To determine the entry for BRAVO, look through the observed wave height data, and find the highest breaker reported (this same information was already used in the determination of ALFA). The height of the highest breaker is entered to the nearest half foot in the space following the designation BRAVO.

CHARLIE

CHARLIE is the breaker period. The observer must record the exact time to the second of the beginning and ending of the wave height observations to accurately compute the breaker period. To compute breaker period, use the WAVE PERIOD COMPUTATION block of the worksheet. The first step is subtracting the time of beginning the wave height observations from the ending time and entering the difference in the elapsed time space of the WAVE PERIOD COMPUTATION block. The second step in computing breaker period consists of converting elapsed time in minutes and seconds entirely to seconds of elapsed time. This may be accomplished as follows:

1. Multiply the number of minutes of elapsed time by sixty to convert minutes to seconds.
2. The result of step one above may now be added to the seconds of elapsed time to obtain total elapsed time in seconds.

The total elapsed time in seconds is entered in the space provided (Total seconds = ____) of the WAVE PERIOD COMPUTATION block of the worksheet (figure 2-1-6). The final step in computing CHARLIE is dividing TOTAL SECONDS by 100. To enter the breaker period on the worksheet, round it off to the nearest half second.

DELTA

DELTA is the percentage of breakers by type. To determine the percentage of each type, use the wave height observation and count the number of p's, s's, and x's entered. Count each type separately (this automatically gives a percentage because there are 100 waves). For the

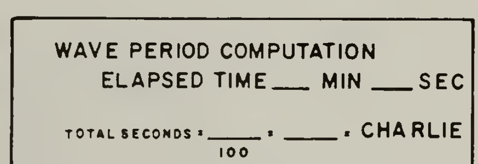


Figure 2-1-6.—Wave period computation.

entries on the worksheet, write the number counted per type in the applicable space. Add the numbers entered on the worksheet, and if the sum total is not 100, go back and recount until the sum of the numbers entered equals 100.

ECHO

ECHO is the angle the breaker makes with the beach. It is always determined as moving *toward* the right or left flank. Left flank or right flank refers to directions—left or right as seen *from* the sea. *As you stand on the beach looking seaward, remember that the coxswain's left flank is on your RIGHT.* In the diagram used in figure 2-1-7, the breakers are making a 30° angle with the beach, and moving toward the right flank. If several breaker angles exist and breaker lines are moving toward both flanks, the following entry could be made: ECHO 10-20 TOWARD R/L FLANK. If the breakers are parallel to the beach, the entry would be: 0 TOWARD R/L FLANK.

FOXTROT

Littoral (or longshore) currents (FOXTROT) flow parallel and adjacent to the shoreline. They

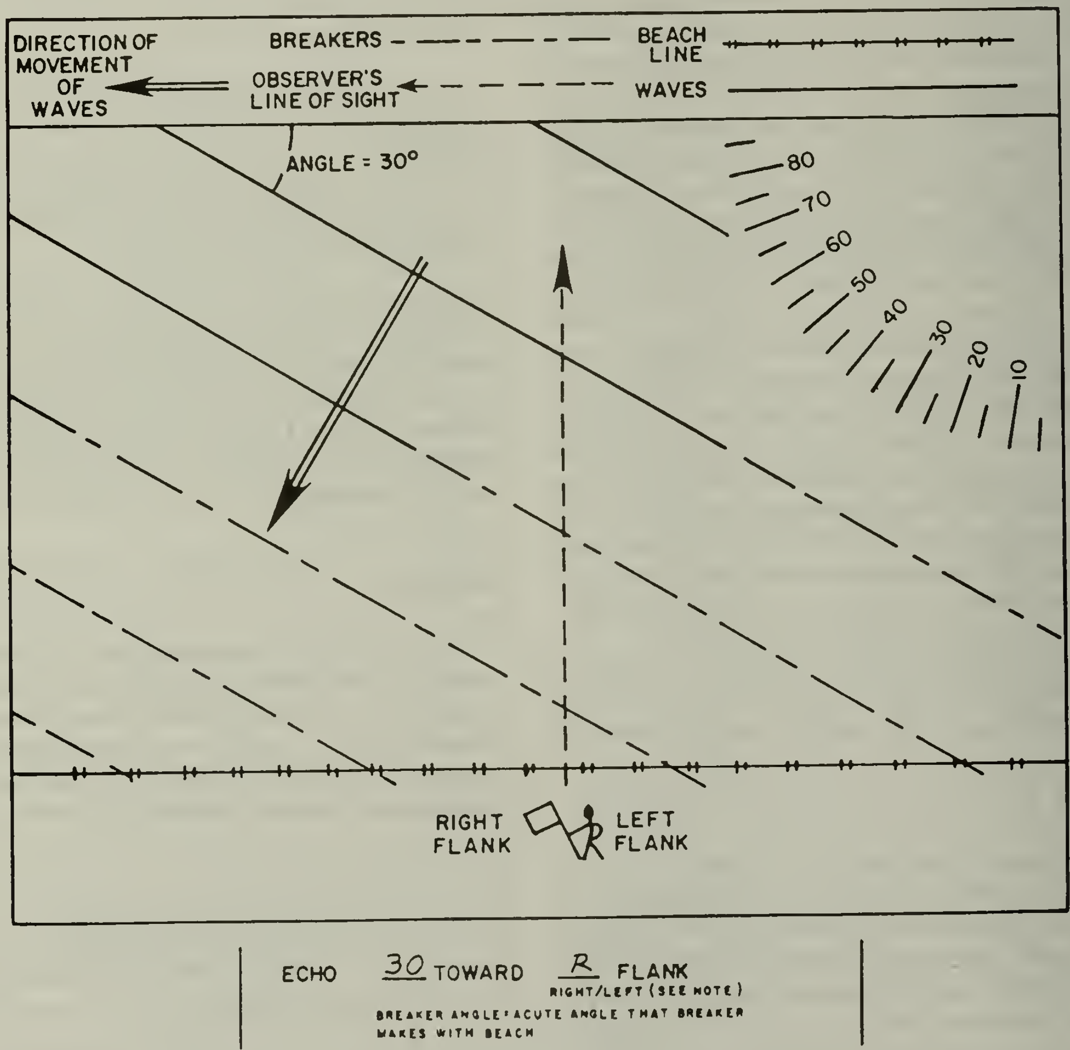


Figure 2-1-7.—Breaker angle chart.

are most commonly found along straight beaches and are caused by waves breaking at an angle with the beach. The littoral current is determined by throwing an object that floats into the water immediately in front of the innermost breaker and by pacing off the distance in feet that it moves in one minute. Each ten feet per minute of movement is equal to one-tenth (0.1) knot of littoral current. Several measurements should be made and the results averaged to ensure that the most representative current is reported.

GOLF

GOLF includes information about the surf zone. The surf zone is the area extending from the outermost breaker line (or where the waves start to break) to the limit of the uprush on the beach. GOLF is determined by merely counting the number of breaker lines and estimating the width of the surf zone.

HOTEL

This section is used to report any significant factors that might influence successful boat operations. Some mandatory remarks are:

1. WEATHER—Report presence of rain, thunderstorms, lightening, etc.

Example:

HEAVY RAIN/THUNDERSTORM 10 MILES SE

2. VISIBILITY—Estimate in miles and report any obstructions to visibility.

Example:

VSBY SEAWARD UNRESTRICTED VSBY INLAND 2 MILES FOG

3. WIND—Estimate relative wind direction and speed in conjunction with the diagram in figure 2-1-8 and examples that follow.

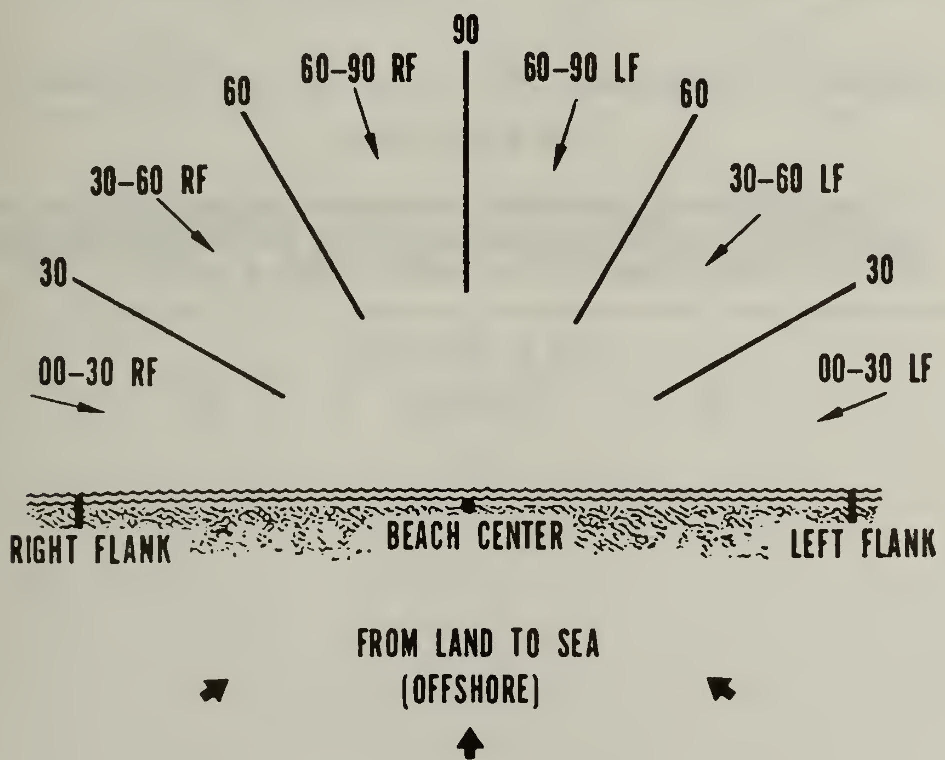


Figure 2-1-8.—Wind direction relative to the beach.

Onshore winds are reported in the following increments:

000

000-030

030

030-060

060

060-090

090

These increments also include the flank (RF for right and LF for left) with the exception of 090.

Example of relative wind:

REL WIND 030-060 LF 15 KTS

NOTE: Always include the abbreviation REL when reporting relative wind. Offshore winds are reported in true wind direction if it is known. If the true wind is not known, report as follows: WIND OFFSHORE

Example of true wind:

TRUE WIND 350 DEG 12 KTS

4. SECONDARY WAVE/BREAKER SYSTEM—A series of waves/breakers superimposed upon another series differing in height, period, *or* angle of approach to the beach. Report height, period, and angle if different from the primary system.

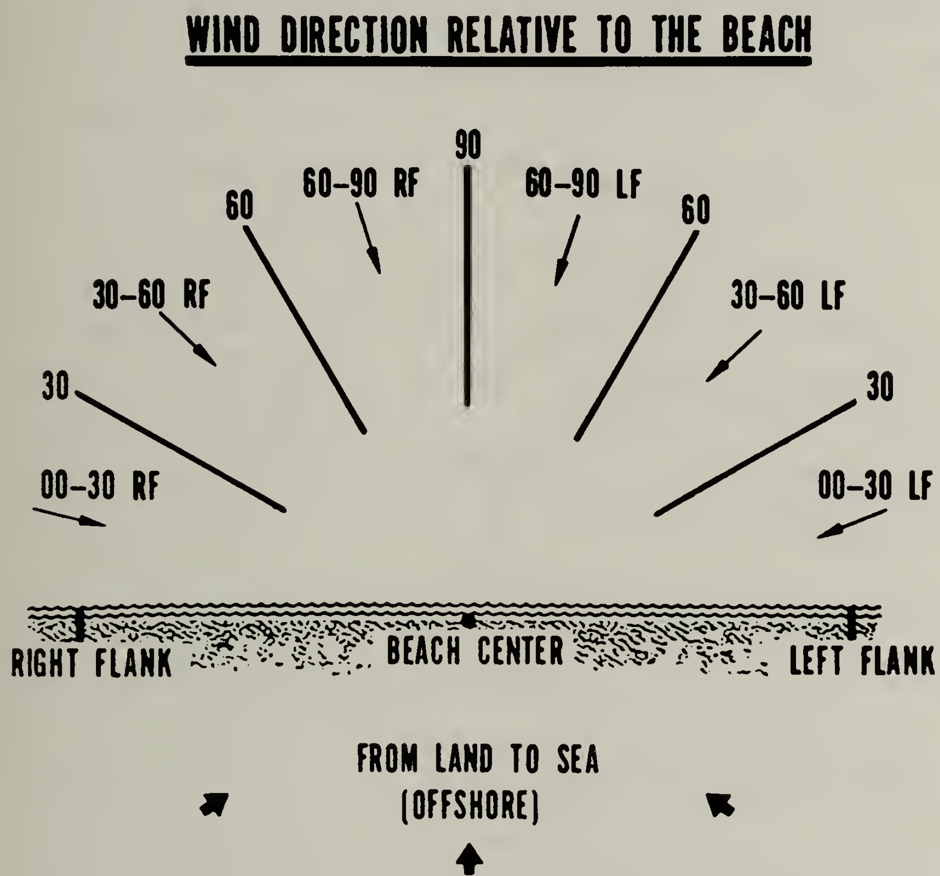
Example:

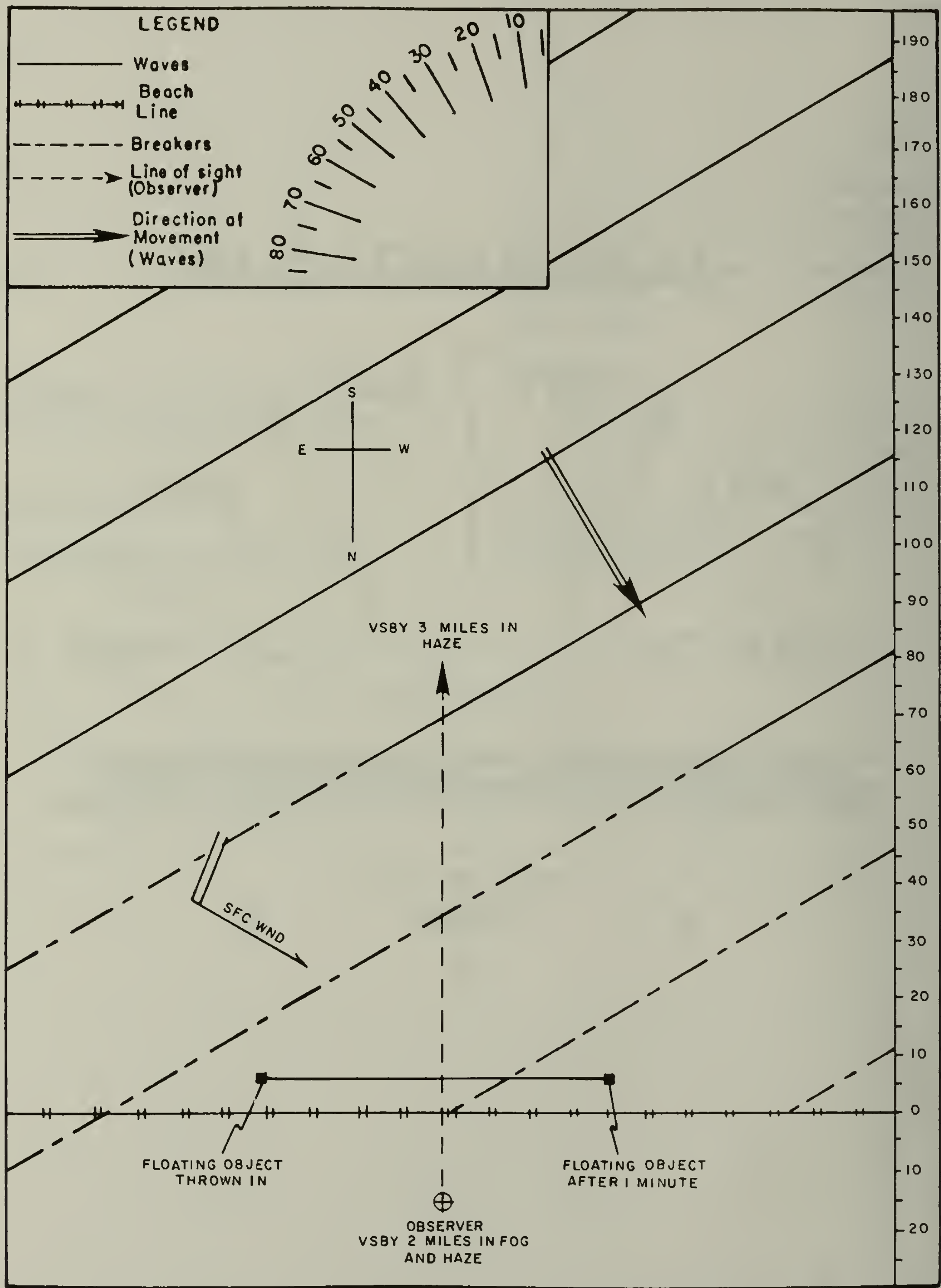
SECONDARY WAVE SYSTEM
ALFA 2 PT 0 BRAVO 3 PT 0

As observer, you may include any other remark you feel is significant and/or may help in making operations safer.

EXERCISE (2-1-1)

1. **From the following wave height observations and diagram of the surf zone, fill in the surf observation report. This is the first surf observation taken on Yellow Beach. It is the eighth of April at 0015L.**


WIND DIRECTION RELATIVE TO THE BEACH
90
60-90 RF
60-90 LF
60
60
30-60 RF
30-60 LF
30
30
00-30 RF
00-30 LF
RIGHT FLANK
BEACH CENTER
LEFT FLANK
FROM LAND TO SEA
(OFFSHORE)


LEGEND
Waves
Beach Line
Breakers
Line of sight (Observer)
Direction of Movement (Waves)
10
20
30
40
50
60
70
80
S
E
W
N
VSBY 3 MILES IN HAZE
SFC WND
FLOATING OBJECT THROWN IN
FLOATING OBJECT AFTER 1 MINUTE
OBSERVER
VSBY 2 MILES IN FOG AND HAZE
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
10
20

WAVE HEIGHT OBSERVATIONS

P = PLUNGING
S = SPILLING
X = SURGING

TIME BEGAN 09 MIN 20 SEC

4.5s	4.0s	3.0s	4.5p	4.0s
4.5s	3.0s	2.5s	4.5p	3.5s
5.0p	2.0s	3.5s	3.5s	4.5s
3.5s	2.5s	4.0s	3.0s	5.0p
4.0s	4.0s	3.5s	4.0s	4.0s
4.5p	4.5p	3.5s	3.5s	4.0s
5.0p	3.5s	3.5s	3.5s	3.5s
5.5p	2.0s	3.5s	4.5s	4.5p
4.0s	1.5s	4.0s	5.0p	4.0s
3.0s	2.0s	4.5p	5.0p	3.5s
2.5s	4.0s	4.0s	5.5p	3.0s
3.0s	4.5p	3.5s	4.5s	4.0s
3.5s	5.0p	3.0s	2.5s	3.5s
4.5p	6.5p	4.0s	3.5s	4.5s
5.5p	6.0p	4.5p	4.0s	4.5s
6.0p	4.5s	5.0p	4.5p	4.0s
5.5p	5.0s	4.5s	4.0s	4.5p
5.0s	4.5s	4.0s	3.5s	4.5p
4.5p	4.5p	4.0s	3.0s	4.0s
4.5p	4.0s	4.0s	3.5s	4.0s

TIME ENDED 23 MIN 30 SEC

WAVE PERIOD COMPUTATION

ELAPSED TIME ___ MIN ___ SEC

TOTAL SECONDS = ___ / 100 = ___ = CHARLIE

NOTE: (ECHO - FOXTROT)
RIGHT OR LEFT FLANK AS SEEN FROM SEAWARD

SURF OBSERVATION REPORT

SUROB NO ______________ BEACH

____
DAY-TIME OF OBSERVATION

ALFA ______ PT ______
SIGNIFICANT BREAKER = AVERAGE OF HIGHEST ONE THIRD TO NEAREST HALF FOOT

BRAVO ______ PT ______
MAXIVUM BREAKER = NEAREST HALF FOOT

CHARLIE ______ PT ______
PERIOD = FIVE TENTHS OF A SECOND

DELTA ___ PLUNGING ___ SPILLING
___ SURGING
BREAKER TYPE = PERCENT APPLICABLE

ECHO ___ TOWARD ___ FLANK
RIGHT/LEFT (SEE NOTE)
BREAKER ANGLE = ACUTE ANGLE THAT BREAKER MAKES WITH BEACH

FOXTROT ___ PT ___ KT ___ TOWARD ___ FLANK
RIGHT/LEFT (SEE NOTE)
LITTORAL CURRENT = MEASURED TO NEAREST TENTH OF A KNOT. ONE KNOT = 100 FT PER MINUTE

GOLF ___ TO ___ LINE IN ___ FT
SURF ZONE SURF ZONE = PREDOMINANT NUMBER OF BREAKERS IN, AND WIDTH OF

HOTEL ______________
____
____
PERTINENT REMARKS = WIND - WEATHER - VISIBILITY SECONDARY WAVE SYSTEM ETC.

WAVE HEIGHT COMPUTATION

FOR HIGHEST 33 WAVES

HEIGHT	X OCCURANCE	= PRODUCT
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___
___	X ___	= ___

TOTAL = ___ / 33 = ___ = ALFA

UNIT 2—LESSON 2

UPPER AIR OBSERVATIONS

OVERVIEW

Identify the basic procedures for collecting, recording, and preparing for transmission of upper air observations.

OUTLINE

Preparation for release

Release and recorder record

Preparation of adiabatic charts

UPPER AIR OBSERVATIONS

Some naval ships, all mobile environmental teams, some overseas stations, and a few stateside stations take radiosonde observations as prescribed in the WMO upper air program.

The complexity of this program requires the standardization of the evaluation procedures, entry of data on the proper forms, and the submission of these forms to cognizant authority.

The accuracy of a radiosonde observation is controlled by several factors. Prerelease checks of the ground equipment are the most important. Others are the accurate evaluation of the recorder traces and applying accurate corrections to the recorder traces.

Failure to select the proper mandatory/significant levels, to apply the needed corrections carefully, or to code the data properly could cause an otherwise excellent sounding to be inaccurate and useless. This gives the forecaster a false representation of upper air conditions.

It is your responsibility to learn to accurately evaluate the data derived from the recorder record, to compute the data on charts or to enter the data correctly into computers, whichever is required, and to encode this information for transmission.

NOTE: Encoding procedures are covered in Unit 3, Lesson 8.

Learning Objective: Identify the basic procedures for collecting, recording, and preparing for transmission of upper air observations.

PREPARATION FOR RELEASE

Before the radiosonde transmitter can be released for flight and subsequent evaluation of the data, you must make certain preliminary checks. The transmitter and ground equipment must be checked and prepared, the balloon inflated, and the train assembled.

The order in which you perform the preliminary operations is governed by the length of exposure time, warm-up time required for the various pieces of equipment, and the needs of the station.

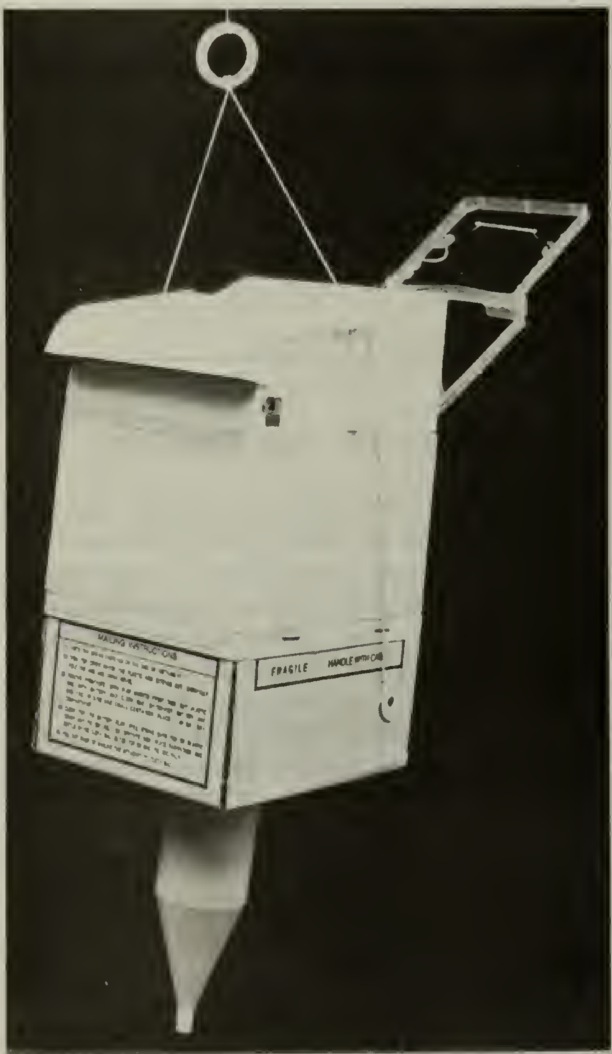
You may perform several of the operations at the same time; you must start early so that the release can be made on schedule.

NOTE: Prior to each sounding, check the recorder paper, data printed paper, and the ink supply to determine if there is enough to meet the needs of the observation.

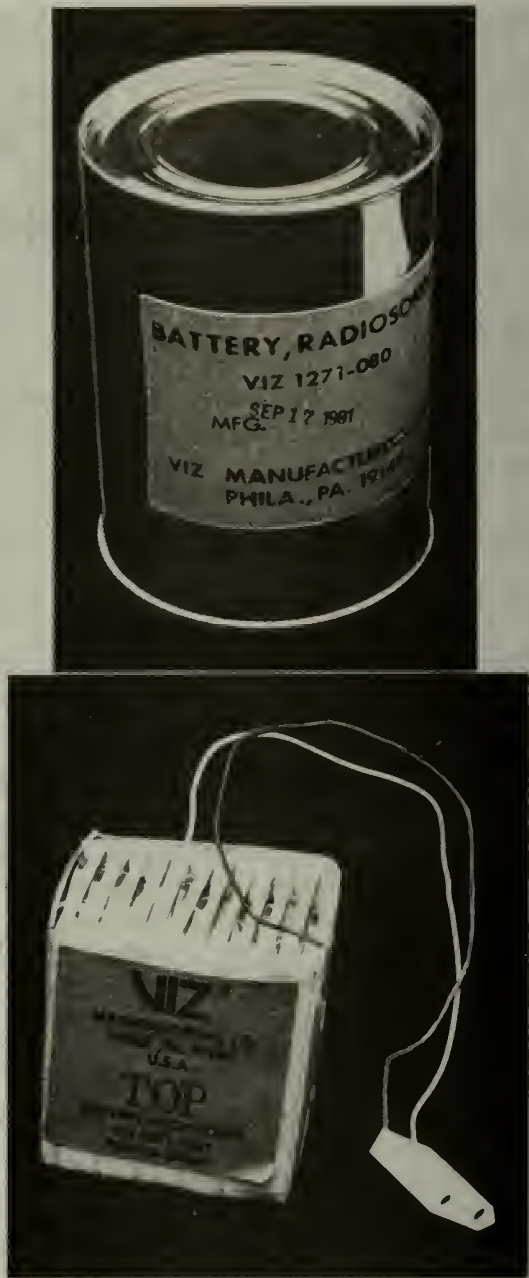
RADIOSONDE PRERELEASE CHECK

The radiosonde (VIZ ACCU-LOK), as shown in figure 2-2-1, prerelease check is necessary to determine if the factory calibration is correct. Here, for the first time, you use all of the equipment; the radiosonde set 1680 or 403 MHz and the radiosonde receptor AN/GMD-1( ) or AN/SMQ-1( ).

NOTE: This section only covers the prerelease check for the VIZ ACCU-LOK radiosonde. The procedure for a baseline check of the old radiosonde can be found in FMH-3.



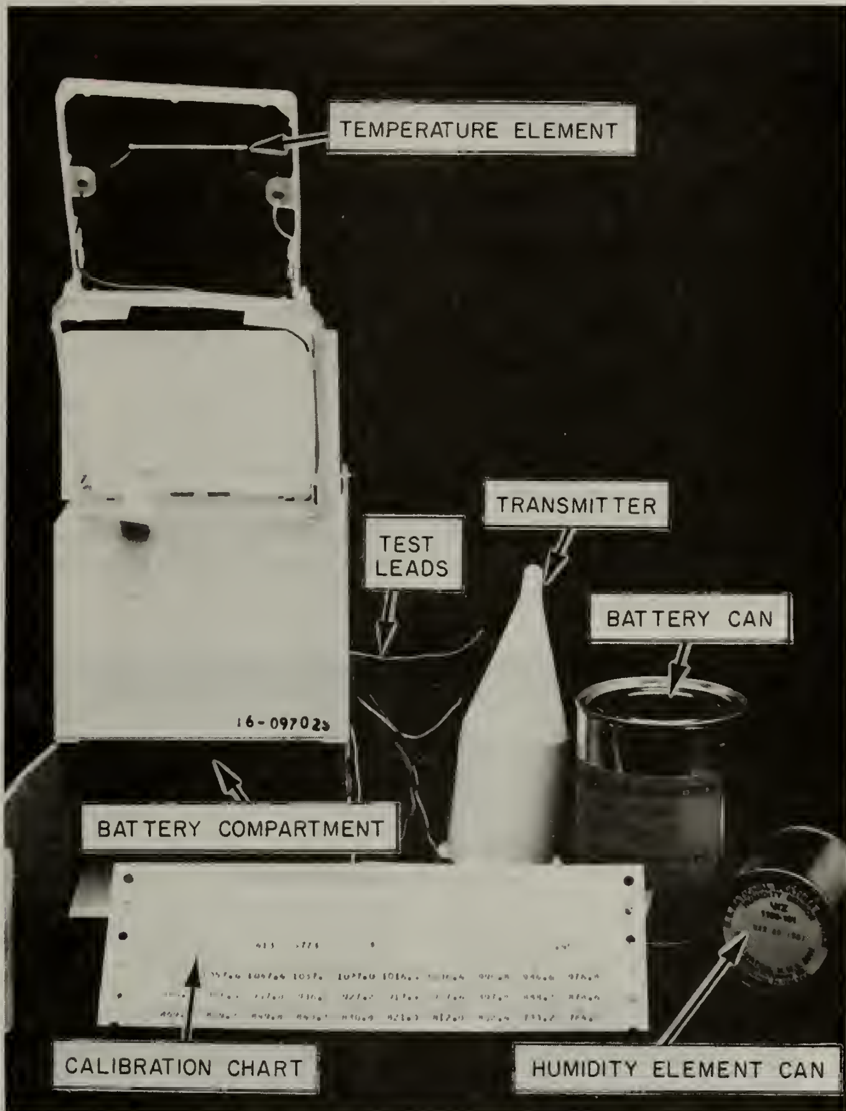
209.453
Figure 2-2-1.—Radiosonde with transmitter installed.



209.454
Figure 2-2-2.—Battery and container.

Activation of Battery

The batteries used with the VIZ ACCU-LOK transmitter (figure 2-2-2) are the water-activated type. Each battery container has a copy of activation instructions. You must strictly adhere



209.455

Figure 2-2-3.—Radiosonde.

to these instructions so the life of the activated battery is neither shortened nor damaged. When you are wetting the battery, care must be taken to keep the battery socket away from the water.

NOTE: Procedures for voltage checks are found in FMH-3.

Installation of Antenna or Transmitter

Install the antenna or transmitter in accordance with instructions issued for the type and series of radiosonde in use. You should install the transmitting antenna or transmitter in the radiosonde before you connect the battery to avoid damaging the transmitter circuit. (See figure 2-2-3.)

Installation of Thermistor

On most radiosondes used by the Naval Oceanography Command, the thermistor is installed at the factory (figure 2-2-3). If it is not

already installed or if a replacement is needed, you must solder the thermistor leads to the leads on the outrigger of the radiosonde prior to the prerelease check. The thermistor should always be handled by its leads to avoid touching the white coating.

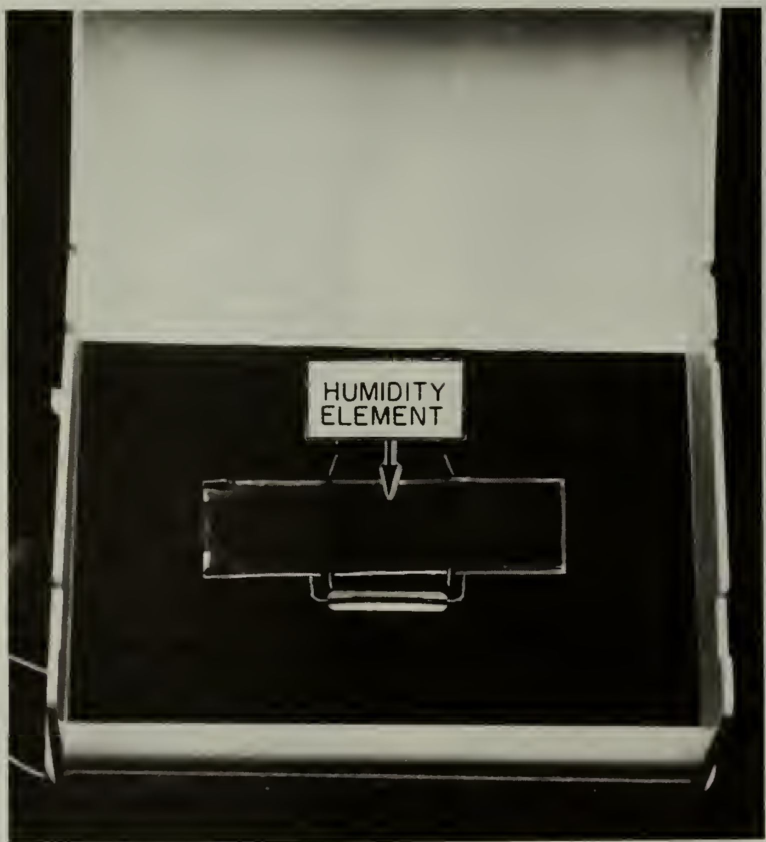
Installation of Hygristor

The hygristor element is packed in a closed, air-tight container for shipment (figure 2-2-4). You should not open the container until just before you prepare the radiosonde prerelease check. Once the container is opened, the hygristor should be handled by its edges. You must take considerable care to ensure that you avoid contact between the film and the skin or with any other foreign substances. If contact with the film should occur, the element must be rejected.

PREFLIGHT CIRCUIT CHECK

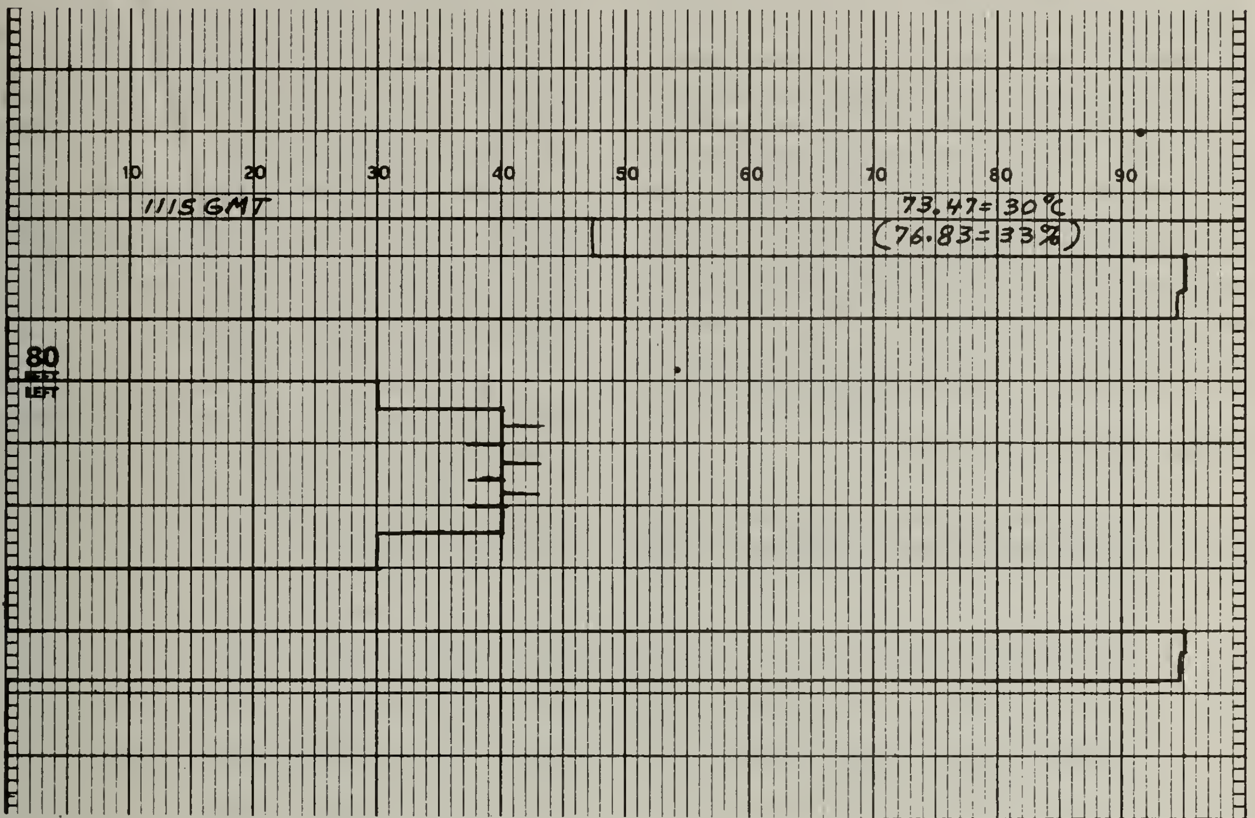
After the radiosonde has been put together, you must perform a preflight circuit check. This check will provide you with data for computing the temperature and relative humidity (figure 2-2-5).

Throughout this manual, the term "ordinate" is used as equivalent to the terms "Temperature Ordinate," "Chart Division," and "Frequency Division" that are found on the various types of evaluators. The left edge of the recorder trace is used for all evaluations. An evaluator is used to convert temperature and relative humidity ordinate values from the recorder record to temperature in degrees of Celsius and relative humidity in percent. Care must be exercised that the evaluator used is appropriate for the thermistor and hygristor used.



209.456

Figure 2-2-4.—Radiosonde with humidity element installed.



209.457

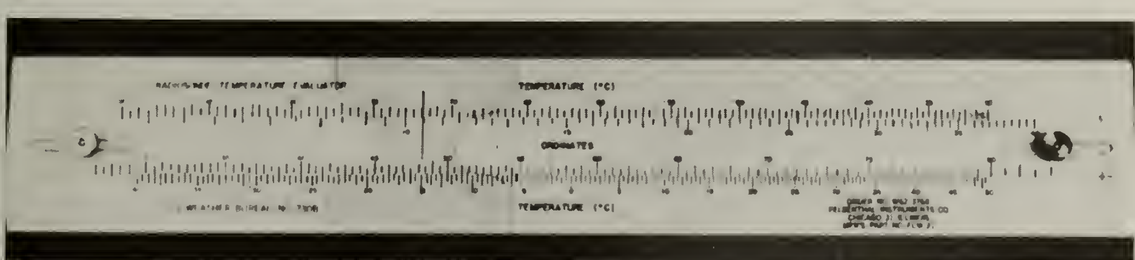
Figure 2-2-5.—Recorder record showing pre-flight circuit check.

NOTE: Complete procedures for performing a preflight check are listed in FMH-3.

Setting Temperature Evaluator

You use the appropriate temperature evaluator (figure 2-2-6) for the radiosonde in use. Set the 30.0 °C opposite the corresponding temperature ordinate value as recorded on the baseline check data block on the MF3-31A, and the preflight circuit check.

The two scales of the evaluator are locked together to retain this setting which must not be altered during the subsequent RAOB. A short



209.458

Figure 2-2-6.—Temperature evaluator.

piece of tape may be used to lock together the scales if a locking device is not furnished with the evaluator. Certain limits on the ordinate scale of the evaluator have been established within which the 25 °C line must fall. For the prebaselined radiosonde, the 25 °C must fall between 69.5 to 73.5 ordinate. If the limits of the temperature evaluator are exceeded, set the radiosonde aside and have another thermistor installed at a convenient time. You can use the standby radiosonde and take another preflight check. If you release a radiosonde that does not have the 25 °C temperature within limits, you must release another one.

Setting Humidity Evaluator

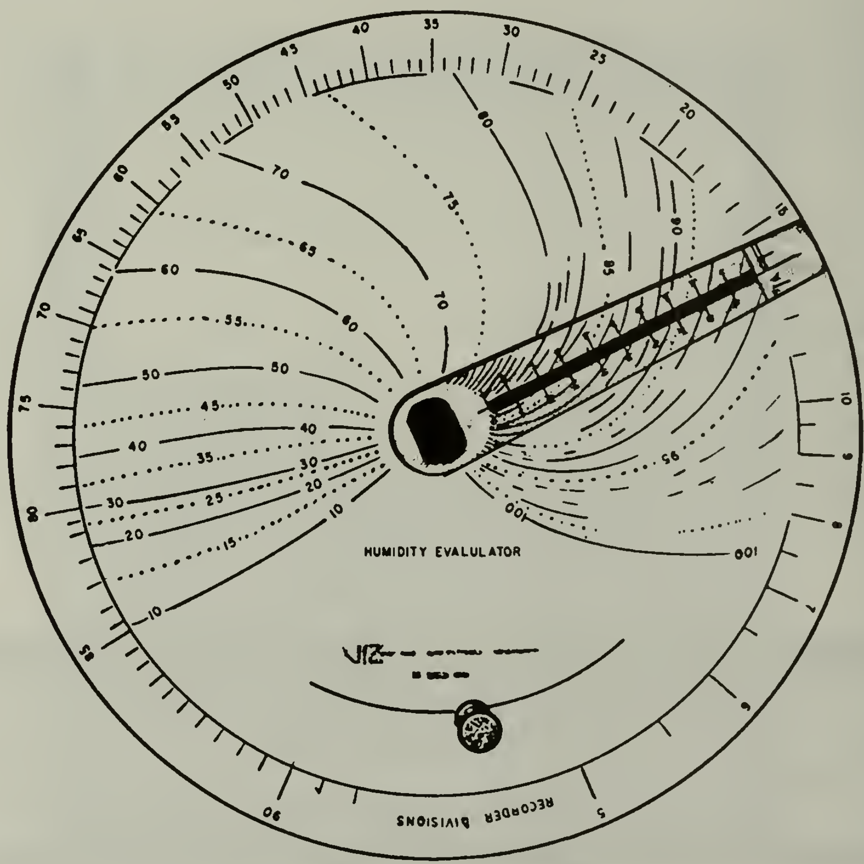
The appropriate humidity evaluator (figure 2-2-7) for the prebaselined radiosonde is the U.S. National Weather Service number 8002 yellow evaluator. Make sure that the 8002 evaluator is only used with the yellow label hygristors.

Set the cursor hairline on the humidity ordinate value you obtain from the baseline check data block on the MF3-31A.

Rotate the humidity disk until you have the humidity value of 33 percent (found on the family of curve lines) under the cursor line and the 30.0 °C temperature. Lock the evaluator.

PRESSURE COMPUTATIONS

Prior to releasing a radiosonde, you must make a pressure contact setting. To determine this contact setting, use station pressure in conjunction with a calibration chart (figure 2-2-8). The procedures for computing this setting are described in FMH-3.



210.257

Figure 2-2-7.—Humidity evaluator.

DATE________ RELEASE TIME, G.M.T. ________ SOUNDING NO. ________

STATION COMPUTED NO. DETENT CLICKS 5 + 15

BAROSWITCH SERIAL NO. 413 - 5773 DETENT CLICK VALUE .45

	1 1057.6	2 1047.4	3 1037.0	4 1027.0	5 1016.4	6 1006.4	7 996.8	8 986.6	9 976.8
10 966.8	11 956.6	12 947.0	13 936.8	14 927.2	15 917.4	16 907.6	17 897.8	18 888.2	19 878.6
20 869.0	21 859.2	22 849.8	23 840.2	24 830.8	25 821.0	26 812.0	27 802.4	28 793.2	29 784.0
30 774.6	31 765.4	32 756.0	33 747.0	34 737.8	35 728.8	36 719.6	37 710.8	38 701.8	39 692.8
40 684.2	41 675.0	42 666.2	43 657.4	44 648.6	45 640.0	46 631.4	47 622.6	48 613.8	49 605.8
50 597.4	51 588.8	52 580.6	53 572.4	54 563.8	55 555.8	56 547.4	57 539.4	58 531.2	59 522.8
60 515.2	61 507.2	62 499.6	63 491.6	64 483.6	65 476.2	66 468.6	67 460.8	68 453.2	69 446.0
70 438.4	71 431.0	72 423.8	73 416.4	74 409.2	75 402.0	76 395.2	77 388.2	78 381.2	79 374.6
80 368.0	81 361.4	82 355.0	83 348.6	84 342.2	85 335.4	86 328.4	87 322.4	88 316.2	89 310.0
90 303.8	91 297.8	92 291.6	93 285.6	94 279.8	95 273.8	96 268.2	97 262.4	98 256.8	99 251.0
100 245.2	101 239.8	102 234.6	103 229.0	104 224.0	105 218.8	106 213.6	107 208.8	108 203.6	109 198.6
110 194.0	111 188.8	112 184.2	113 179.6	114 175.0	115 170.6	116 166.0	117 161.6	118 157.8	119 153.2
120 149.2	121 145.6	122 141.6	123 137.6	124 133.6	125 129.8	126 126.2	127 122.4	128 118.8	129 115.0
130 111.8	131 108.0	132 104.4	133 101.2	134 97.8	135 94.8	136 91.2	137 88.2	138 85.2	139 81.8
140 78.8	141 75.8	142 72.8	143 69.8	144 66.8	145 64.0	146 61.2	147 58.2	148 55.2	149 52.4
150 49.8	151 47.0	152 44.2	153 41.4	154 38.6	155 36.0	156 33.2	157 30.4	158 27.6	159 24.8
160 22.0	161 18.8	162 16.2	163 13.4	164 10.4	165 7.6	166 4.2	167 .0	168 .0	169 .0
170 .0	171 .0	172 .0	173 .0	174 .0	175 .0	176 .0	177 .0	178 .0	179 .0

CONTACT VALUES FOR MANDATORY LEVELS

1000	6.66	300	90.63	70	142.93	7	165.17
850	21.97	250	99.17	50	149.92	5	165.76
700	38.20	200	108.72	30	157.14	3	166.35
500	61.94	150	119.80	20	160.62	2	166.64
400	75.29	100	133.35	10	164.14	1	166.94

209.459

Figure 2-2-8.—Baroswitch pressure calibration chart.

EXPOSURE BEFORE RELEASE

The sensing elements and the radiosonde box adjust to changes in temperature quite rapidly. The time needed to tie the instrument to the train and get ready for the release is normally sufficient for the radiosonde to be conditioned to the change of temperature from a warm room to the outside air. However, if the temperature difference between the shelter and the outside air exceeds 30°C, an exposure time in the outside air of at least 10 minutes should be allowed. The radiosonde, which is ready for release, should be conditioned to the outside air in a sheltered, unheated place for free circulation of air around the radiosonde.

EXERCISE (2-2-1)

Fill in the missing words in statements 1 through 5.

1. **Before you release any radiosonde for flight, the transmitter and ground equipment must be ____________________ and prepared, the balloon inflated, and the train assembled.**

2. **While you activate a radiosonde battery, care should be taken to keep the battery ____________________ away from the water.**

3. **When you install a hygristor, considerable care should be taken to ensure that ____________________ is avoided between the film and the skin or with any other foreign substances.**

4. **When evaluating the recorder record trace, the____________________ edge of the trace is used for all evaluations.**

5. **When setting a temperature evaluator for a prebaselined radiosonde, the ____________________ must fall between 69.5 to 73.5 ordinates.**

RELEASE AND RECORDER RECORD

As soon as the radiosonde is airborne, evaluation of the recorder record begins. However, under standard procedures, certain entries are made on the recorder record during the following occurrences: immediately prior to release, during the flight, and after termination of the flight.

PROCEDURES PRIOR TO RELEASE

There are a number of procedures that must be done prior to the release. The following paragraphs cover some of these procedures. However, for an up-to-date listing of your station procedures, check the Standard Operating Procedures (SOP) manual of your command.

Release Authorization

The local communications command is advised of the release schedule indicating the dates and time of release.

You must coordinate with the local air control division in order to advise them of the schedule of radiosonde flights; arrangements must be made for authorization to release each balloon. You never release a radiosonde balloon without authorization from the air control authorities. It is mandatory that you do this because the balloon, train, and transmitter can present a hazard to aircraft.

The balloon should be released within 5 minutes of the authorized time. The Operations Office normally transmits a NOTAM to this effect. A permanent record must be maintained of the date and time of release of the balloon, the person requesting permission for release, and the release authority.

When aboard a ship at sea, a request to release the balloon must be made to the OOD/Bridge. In addition, depending upon the type of ship, notification to other departments or locations may be required. Refer to your ship's or division's standard operating procedures (SOP) for exact requirements.

Observation Schedule Times

The standard times of observations are 0000, 0600, 1200, and 1800 GMT. Insofar as possible, the release times (actual times of observation) are scheduled as close as conditions permit to 2330, 0530, 1130, and 1730 GMT. Except for earlier releases from moving vessels or specified stations (as provided in special instructions) no other releases are scheduled more than 30 minutes earlier nor more than 30 minutes later than 2330, 0530, 1130, and 1730 GMT. Delayed releases may be made after the standard times of observation, but in no case, later than 0100, 0700, 1300, and 1900 GMT. Special observations may be made outside these specified release times when authorized.

Station Identification Stamp

The station identification stamp normally should be placed within the first fold of the recorder record. The left edge of the stamp is placed at the tenth ordinate line, directly below the preflight circuit check line.

Shore station stamp:

STATION: ADAK, ALASKA
DATE: 14 SEP 1983
TIME OF RELEASE: 2330 GMT
ASCENSION NO: 515
RADIOSONDE SERIAL NO: 49-9048756
REASON FOR TERMINATION: BALLOON BURST
COMPUTER: I. M. NAVY AG2
VERIFIER: U. R. WRIGHT AG1

Shipboard station stamp:

SHIP: USS ENTERPRISE CVN-65
LAT: 34° 57'N
LONG: 179° 36'W
DATE: 14 APR 1984
TIME OF RELEASE: 1135 GMT
ASCENSION NO: 208
RADIOSONDE SERIAL NO.: 530-0494
REASON FOR TERMINATION: BALLOON BURST
COMPUTER: A. T. BURGESS AG3
VERIFIER: R. A. WARD AGCS

Release Procedures and Precautions

Release procedures and precautions vary with every station. The release will vary because of surface wind conditions and location of obstructions. You should be familiar with the area before attempting a release.

RECORDER RECORD

The task of the observer at the recorder is to obtain an accurate and continuous recording of the signal transmitted by the radiosonde. As the radiosonde moves away from the earth's surface, the radio frequency usually drifts slightly, making it necessary for the observer to retune occasionally. Ground equipment with automatic frequency control usually does not require manual retuning during a sounding. The observer at the

recorder evaluates as much of the recorder record as possible while the balloon is ascending (figure 2-2-9). The remainder is completed as soon as possible after the termination of the flight.

Levels are placed on the recorder record to mark the boundaries of strata having differing temperature lapse rates or vertical humidity gradients. Select levels at pressures corresponding to any mandatory levels (mandatory levels are specified in FMH-4).

When you make level selections, do so in the following order:

1. Mandatory pressure levels
2. Temperature significant levels
3. Additional levels
4. Relative humidity significant levels

When selecting levels for temperature, however, you should be aware of the relative humidity trends so that, when necessary, a level may be selected to reflect changes in trends of both temperature and relative humidity.

Identify each significant and mandatory level by drawing a line completely across the recorder record parallel to the printed time lines (figure 2-2-9).

NOTE: For a complete description of the level selections refer to FMH-3.

EVALUATION AND ENTRY OF DATA ON LEVELS

After you have drawn each level, you must enter the time of the pressure contact, the temperature ordinate value and the humidity ordinate value. This data will then be entered into a computer or put on a adiabatic chart (MF3-31A) for evaluation and encoding.

NOTE: For a complete description on the procedures for evaluation and entry of the data on each level refer to FMH-3.

Time of Levels Selected

Enter the elapsed time from release for each level on the recorder record at the extreme left and to the nearest tenth of a minute.

No two levels may have the same elapsed time, regardless of how close the two levels are. The upper one must be at least 0.1 minute later.

Pressure Contact Values

At each level, you determine the pressure-contact value to the nearest tenth contact by counting the contacts from the preceding reference contact numbered. You then enter the values of the pressure contacts immediately above the level and to the left of the temperature trace. Estimate the fractional value of the contact at release by comparing it with the length of the following contact.

NOTE: To determine the contact value for the surface and termination levels, refer to FMH-3.

Temperature Ordinate Value

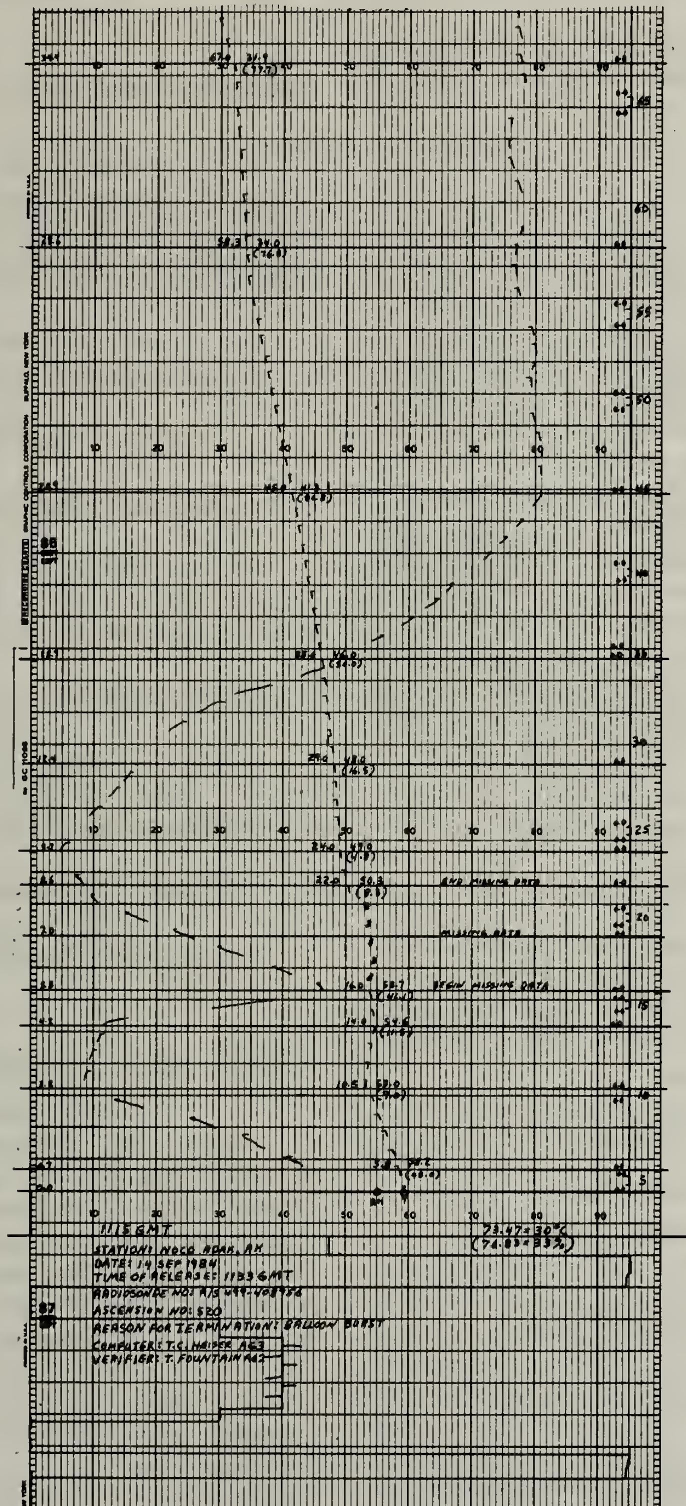
You read the temperature ordinate value to the nearest tenth where the left edge of the temperature trace intersects the level line. When you draw a level between two temperature contacts, draw a line between the top edge of the lower and the bottom edge of the upper contact. At the intersection of this line with the horizontal line, read the temperature ordinate pertaining to the level. When you draw the level in an adjusted low-reference, correct the lower temperature ordinate before connecting these temperature traces. Enter the temperature ordinate values in tenths immediately above the level and to the right of the temperature trace.

Relative Humidity Ordinate Value

Be sure you read the relative humidity ordinate values to the nearest tenth and enter them immediately to the right of the temperature trace and below the levels. Enclose these values, their recorder and drift corrections, and the corrected values in parentheses.

Corrections to Temperature and Humidity Ordinate Values

Check each temperature and humidity ordinate value entered on each level for a recorder



209.460

Figure 2-2-9.—Recorder record.

correction, drift correction, and paper alignment correction.

NOTE: For a complete description of the application of these corrections refer to FMH-3.

SUPERADIABATIC LAPSE RATE

All segments on the recorder record which have been evaluated as having a superadiabatic lapse rate (the lapse rate equals or exceeds 9.8 °C/km) must be rechecked for possible errors in evaluation of the data. If no errors are found, enter "rechecked" with arrows pointing to the bounding levels of the stratum.

Use no personal bias while evaluating the recorder record. Superadiabatic lapse rates (supers) must not be hidden by reevaluating the recorder record. Assuming the temperature outrigger is fully extended, the proper length of train is placed between the balloon and the radiosonde; if no obvious malfunctioning of the radiosonde and/or ground equipment is evident, evaluate the recorder record as accurate.

ANNOTATION OF RECORDER RECORD

When you select levels that reflect doubtful or missing data, annotate the recorder record. Make entries just above the level line where they do not obscure other data. Annotations and their meanings are as follows:

BMD —Begin Missing Data

EMD —End Missing Data

BMRH —Begin Missing Relative Humidity

EMRH —End Missing Relative Humidity

BDTD —Begin Doubtful Temperature Data

EDTD —End Doubtful Temperature Data

MISDA—Missing Data

NOTE: Enter MISDA contraction on the level you select in a strata of missing data.

REASON FOR TERMINATION

Enter the reason for the termination of the sounding slightly above the last ascent level evaluated and in the station identification data stamped on the recorder record. A partial list of reasons follows:

Balloon burst

Leaking or floating balloon

Balloon forced down by icing

Chart limitations

Battery failure

* Switch failure

* Weak or fading signal

* Radiosonde failure

* Ground equipment failure

* Other (power failure, interference, etc.)

NOTES AND COMMENTS

Notes and comments pertinent to the observations may be entered on the recorder record below the station identification data. You are encouraged and requested to make any entries on the record that may assist in clarifying, qualifying, or explaining unusual aspects of the record. The provisions of this paragraph should not be construed as authorizing the solicitation of such instructions and opinions which should properly be made the subject of a letter or memorandum.

---

* These should be explained by a note on the first fold of the recorder record.

EXERCISE (2-2-2)

Fill in the missing words in statements 1 through 7.

1. **Make a complete surface observation at release or just prior to release. Make sure that not more than ________________ minutes of elapsed time occurs between the beginning of the observation and the release.**

2. **The station identification stamp normally should be placed within the first fold of the recorder record. Place the left edge of the stamp at the ________________ ordinate line directly below the preflight circuit check line.**

3. **The priority for selecting levels on the recorder record are mandatory, temperature, ________________, and humidity.**

4. **Enter the time for all levels at the extreme ________________ side of the level and to the nearest tenth of a minute.**

5. **Enter the pressure contact value for each level immediately above the level and to the ________________ of the temperature trace.**

6. **The temperature ordinate value for each level is entered immediately ________________ the level and to the right of the temperature trace.**

7. **All humidity ordinate values for each level are entered and enclosed in ________________.**

PREPARATION OF ADIABATIC CHARTS

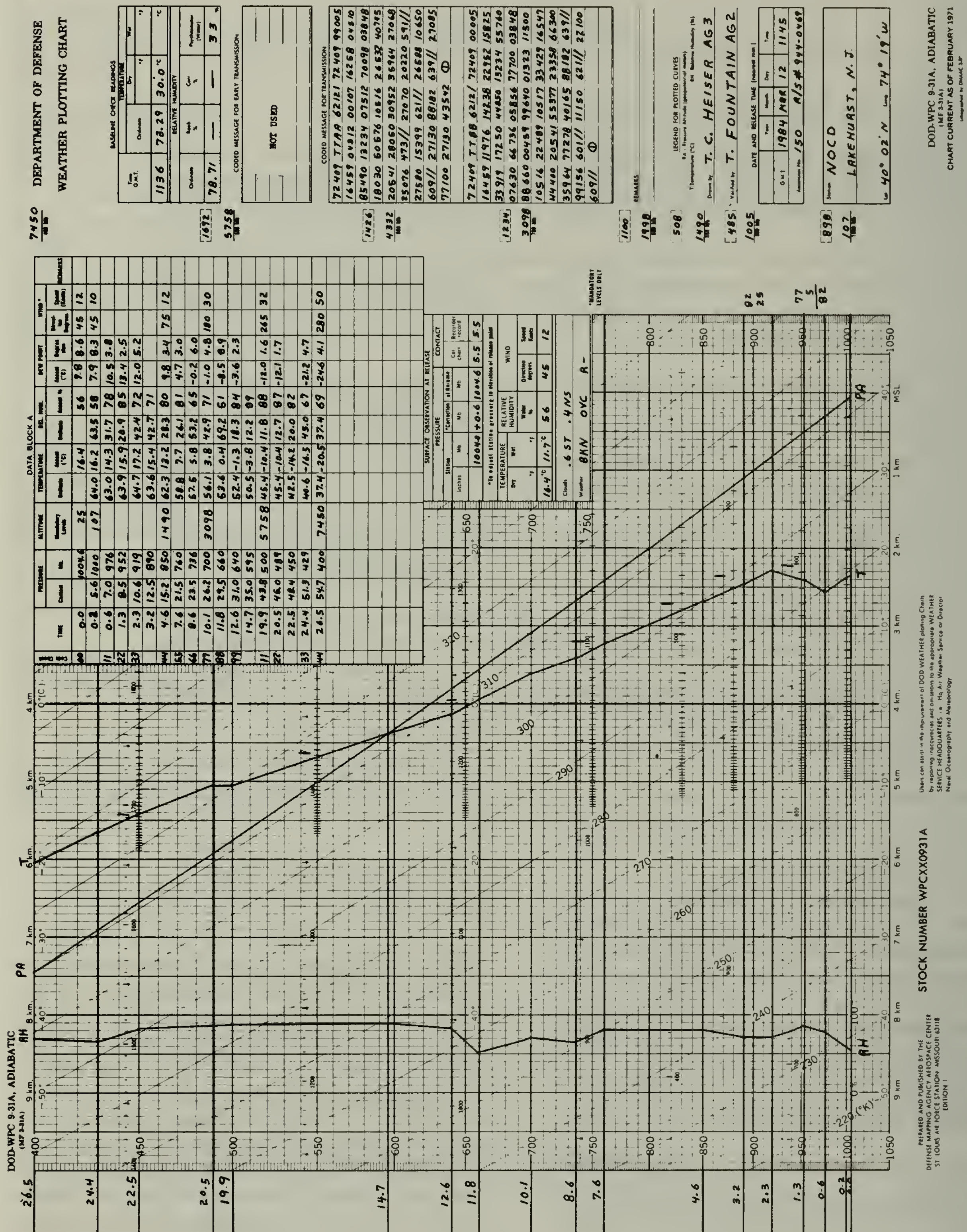
The purpose of the adiabatic charts (MF3-31), (shown in figures 2-2-10, 11, 12) is to provide a working space for recording, computing, graphing, and coding RAOB data extracted from the recorder record.

ENTERING DATA ON MF3-31( )

Prepare the form MF3-31( ) in a clear, legible manner so that the forms may be microfilmed for use as a climatological record and data can be easily extracted for punched cards.

SURFACE OBSERVATION AT RELEASE

Make a complete surface observation as close as possible to the time of the release and enter the data on the observation form under the caption "Surface Observations at Release." This observation may be taken just before the release provided you do not delay the release. Do not let more than 10 minutes elapse between the beginning of the surface observation and the actual release. Whenever the surface observation is not taken within 10 minutes before the release time, take as soon as possible after the release. (Refer to figure 2-2-10.)



209.461

Figure 2-2-10.—Sample Form MF3-31A.

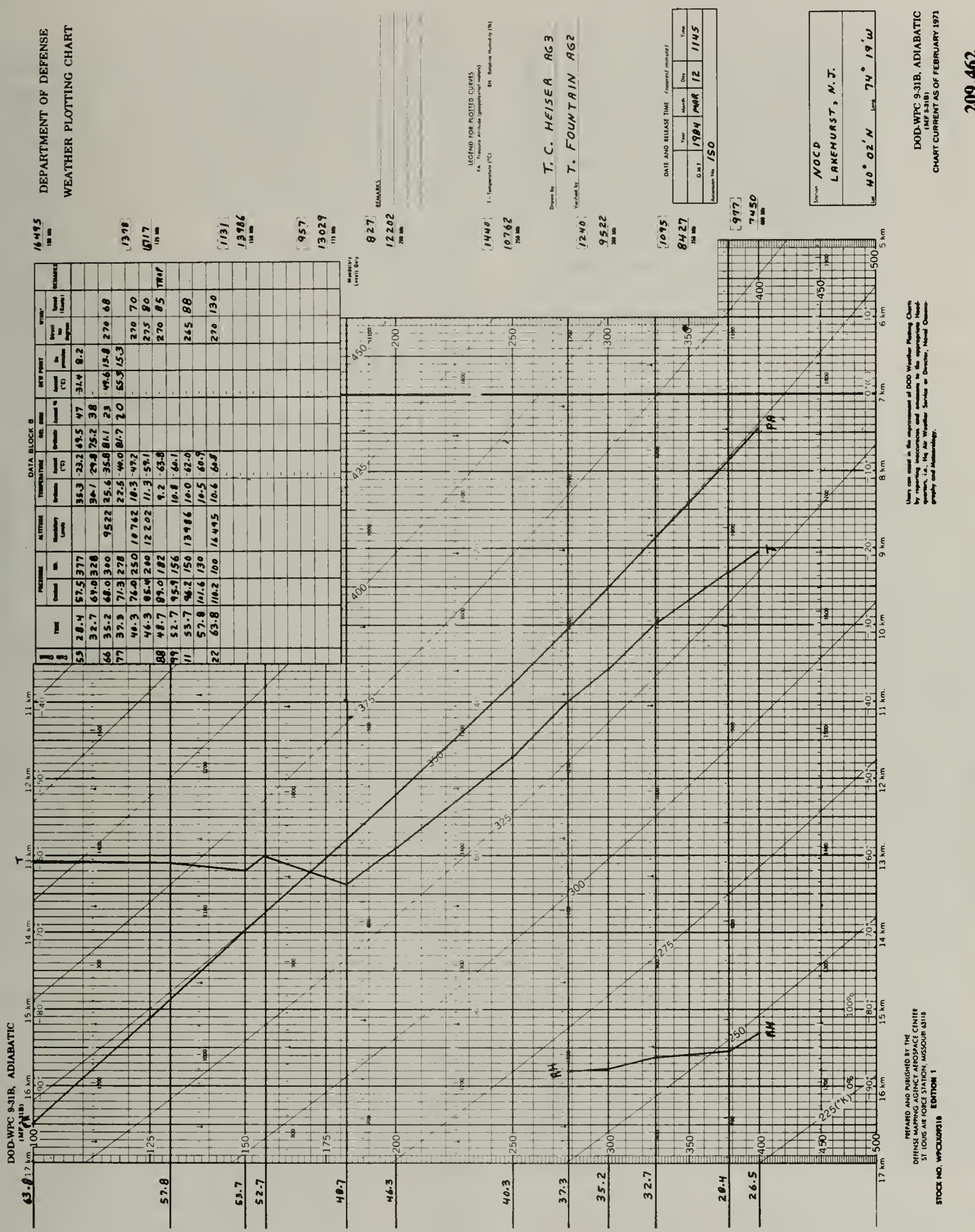


Figure 2-2-11.—Sample Form MF3-31B.

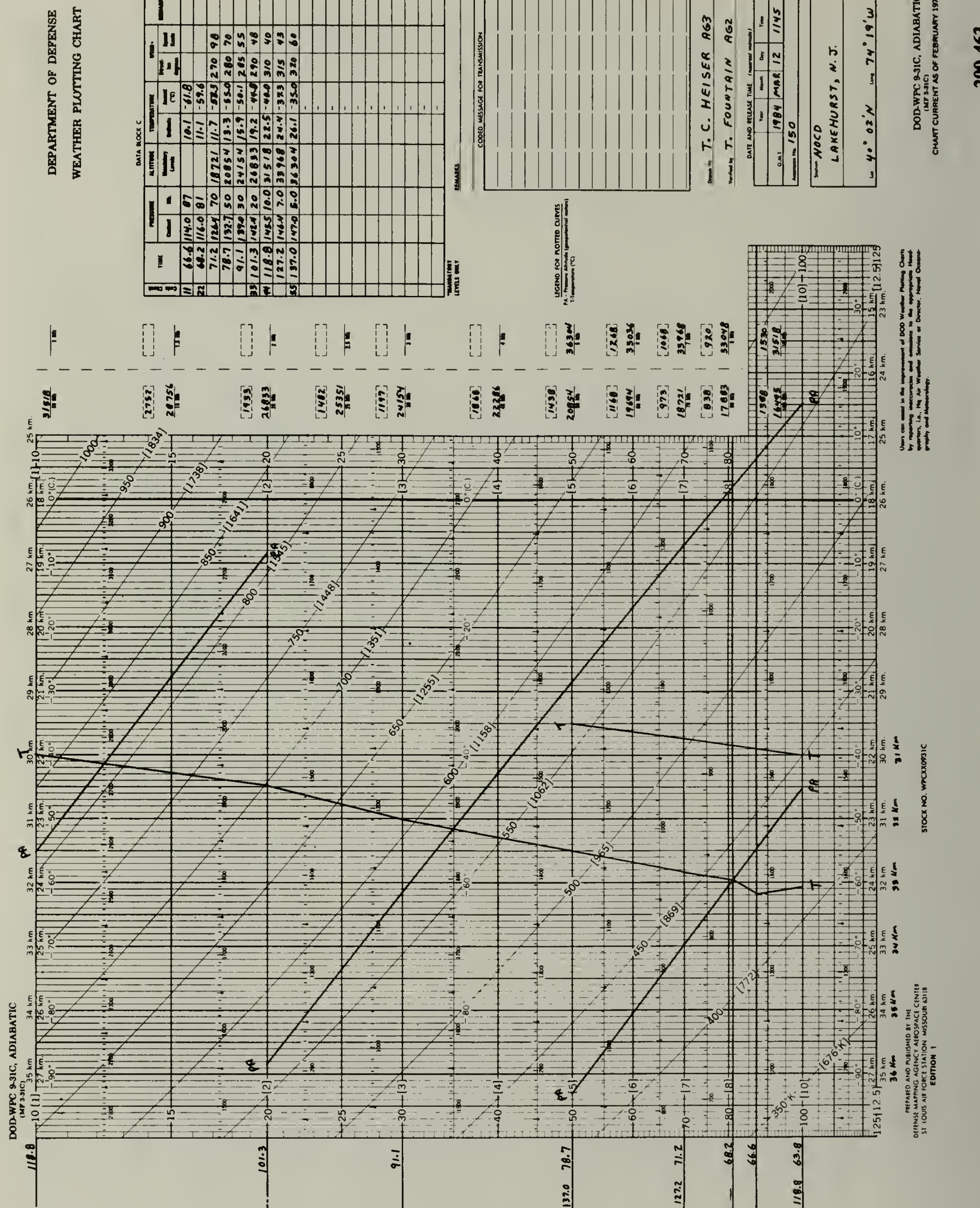


Figure 2-2-12.—Sample Form MF3-31C.

DATA BLOCK

A data block is printed on each of the adiabatic charts. Enter only the data in each block that pertains to the corresponding adiabatic chart. However, enter data pertaining to the levels common to MF3-31A and B (500—400 mb) only in Data Block A; enter levels common to MF3-31B and C (100—125 mb) only in Data Block B.

For each level you evaluate on the recorder record, enter the time, pressure contact, temperature ordinate, and relative humidity ordinate in the appropriate columns.

PLOTTING DATA ON THE MF3-31( )

After you complete the required computations in the Data Blocks, plot the temperature and relative humidity against the pressure on the adiabatic charts. This will give you a vertical profile of the upper atmosphere above the station.

CODED MESSAGE FOR TRANSMISSION BLOCK

The procedure for encoding the radiosonde message can be found in Unit 3, Lesson 8 of this manual. However, the coded message will be entered on the MF3-31A or C in the "Coded Message for Transmission" block. Enter each group in the message on a segment of the broken lines provided for the entries. Make corrections in red after the data have been transmitted without obliterating or erasing the data as they originally appeared in the transmitted message.

VERIFICATION OF FORMS

After the completion of the recorder record and the adiabatic forms, the next step is verification of your entries. Verification is one of the most important jobs on an upper air section. The coded message should be checked first before transmission, verifying as much other data as possible; then comes the task of very carefully checking and going over the recorder record and adiabatic chart.

PURPOSE OF VERIFICATION

The purpose of verification is to ensure not only that the coded message is complete and accurate before transmission (if there is sufficient time before transmission to plot the coded message on a SKEW T, Log P Diagram for the detection of errors), but that the adiabatic charts and punched card data are complete and accurate for climatological use. All forms should be checked by someone other than the original computer for accuracy before being sent to Asheville, North Carolina. Proper verification lowers or eliminates the errors made in computing the sounding.

All weather records from all of the armed services are microfilmed and filed in the archives at Asheville. It is imperative that all records be neat, legible, and accurate. In most cases the errors are not due to procedure, but are the result of carelessness.

SECURING THE EQUIPMENT

After you complete the observation, secure the equipment. This procedure is important in order that all control settings are correct for the next time you energize the equipment. The signal selector switch should be in the nonrecording position (GND), the antenna selector in the ground position, and the RF gain turned to OFF.

Remove the flight record; then remove the chart table. Turn the chart drive, main power switch, and heater switch to their OFF positions. (Do not turn off the heater switch if high humidity or extreme cold weather conditions are expected.) Close and lock the recorder door. Remove the power cord from the wall socket (unless the heater is to be left on).

USE OF COMPUTERS

The use of computers to compute the data from the recorder record is beginning to occur at various ship and shore stations. Due to the complexities of computers and their operations, computers are not covered in this manual.

NOTE: Stations using computers make sure all computer data strips are sent to Asheville, NC, at the end of each month.

EXERCISE (2-2-3)

Fill in the missing words in statements 1 through 3.

1. **The purpose of the adiabatic charts (MF3-31( )) is to provide a working space for recording, computing, graphing, and coding RAOB data extracted from the ____________________.**

2. **Data from the recorder record are entered on the MF3-31( ) under the heading ________________ ________________ for evaluation and computations.**

3. **Whenever a surface observation is not taken within 10 minutes before the release time, it is taken as soon as ____________________ after the release.**

UNIT 2—LESSON 3

WINDS ALOFT OBSERVATIONS

OVERVIEW

Identify the procedures for collecting, recording, and preparing for transmission of winds aloft observations.

OUTLINE

Winds aloft observations

Type of equipment

Limiting angles

Observation procedures for RAWINS/RABALS

Winds Aloft Computation Sheet (MF 5-20)

Evaluation of the RAWIN observation

PIBAL observation

A knowledge of the weather conditions existing in the free air above the earth's surface is extremely important in theoretical, statistical, and climatological studies of the atmosphere as well as their importance in the direct application in daily forecasting and for their immediate use by pilots. Coupled with the information concerning surface conditions, this knowledge affords the forecaster another dimension upon which to base his predictions.

Learning Objective: Identify the procedures for collecting, recording, and preparing for transmission of winds aloft observations.

WINDS-ALOFT OBSERVATIONS

Winds-aloft observations are taken to determine the direction and speed of the winds above the observing station. A free-rising balloon which drifts with movements of the atmosphere is tracked by the observing stations. The wind may be determined by one or more of the following methods: PIBAL, RABAL, and RAWIN.

PIBAL (PILOT BALLOON)

A PIBAL is a balloon which is inflated with hydrogen or helium to provide a fixed free lift. It is tracked visually with a theodolite (an instrument used for measuring horizontal and vertical angles). The altitudes of the balloon at successive minutes are based on the average of a large number of flights. In any individual observation, however, local turbulence may alter the ascension rate and the balloon may actually be higher or lower than the assumed altitude. At 1-minute intervals during the ascent, the azimuth and elevation angles of the balloon with reference to the point of observation are read from the azimuth and elevation scales on the

theodolite. Since the height of the balloon is assumed at the time the angles are read, computations of the positions of the balloon at selected minutes as well as computations of directions and speeds of movement of the balloon at selected intervals involve the use of trigonometry. The height to which the balloon can be tracked is governed by many factors. Some of these factors are the speed of winds aloft which may blow it beyond the range of the theodolite; the intervention of an obscuring medium (such as clouds) between the balloon and the observer; and the bursting point of the balloon. The single-theodolite method is used for taking all routine PIBALS.

RABAL (RADIOSONDE BALLOON)

In a RABAL, the balloon used for the radiosonde ascent is tracked with a theodolite in the same manner as that of a pilot balloon. RABALS differ from PIBALS in that the height data necessary to compute the position of the balloon at 1-minute intervals are taken from the radiosonde observation. They are more accurate than PIBALS because no assumption is made of an ascension rate that could be altered by turbulence in the atmosphere.

RAWIN (RADIO OR RADAR BALLOON)

A RAWIN uses the principle of either radio direction finding or radar. In radio direction finding, the signal from a radio transmitter attached to an ascending balloon is tracked by a radio receiver at the station. When radar is used, pulses reflected from a target attached to an ascending balloon are tracked by a combination radio transmitter and receiver at the station. In both radio direction finding and radar, the receiver is equipped with a directional antenna. The positions of the transmitter or target are determined at 1-minute intervals from the azimuth angle and any combination of elevation angle and slant range, elevation angle and height, or slant range and height. This method of securing winds-aloft data is superior to optical methods because the observation may be taken under conditions of weather that would preclude the use of a theodolite.

RAWINSONDE observations give a simultaneous measurement of the pressure, temperature, humidity, and wind direction and speed of the air above the earth's surface. RAWINSONDE observations combine the elements of the radiosonde and RAWIN observations.

TYPES OF EQUIPMENT USED

Tracking equipment, used in taking winds aloft observations is either electronic (RAWIN) or visual (RABAL or PIBAL).

RAWIN EQUIPMENT

The equipment used in obtaining RAWIN observation may be obtained by the use of radar tracking or the AN/GMD-1( ) RAWINSONDE set.

RABAL EQUIPMENT

With RABAL equipment, a balloon-borne radiosonde is sent aloft and the balloon is tracked visually by means of a theodolite. Elevation and azimuth angle readings are taken each minute. They are used in conjunction with the height data from the associated radiosonde observation (RAOB) to compute wind directions and speeds. Visual tracking during nighttime observations is facilitated by attaching a small battery-powered lighting device to the radiosonde train.

PIBAL EQUIPMENT

When making a PIBAL observation, angular bearings of the balloon are taken and recorded each minute of the flight. The balloon is inflated to rise at an assumed rate of free lift. The angular values are used in conjunction with the assumed rate of ascent of the balloon to compute wind directions and speeds of the winds aloft. Tracking the balloon during nighttime observations is made possible by attaching a small battery-powered lighting device to the balloon.

LIMITING ANGLES

The accuracy of GMD-1( ) tracking is seriously affected whenever the angular readings fall within the limiting-angle zone, the boundaries of which vary with the individual installation.

LIMITING-ANGLE ZONE

The limiting-angle zone is regarded as extending 6 degrees in elevation above the horizon or above any object on the horizon (except trees). In azimuth, the zone extends 6 degrees from each side of the object. In the case of trees, the limiting-angle zone of trees extends in elevation to an angle that just clears the tops of the tree or trees, and in azimuth to the edge of the tree or group of trees (figure 2-3-1).

At naval observation stations, wind data are not computed from angular readings within the limiting-angle zone that surrounds any object closer to the RAWIN set than 10 times the height of the top of the antenna reflector. Beyond this range, wind data computations are based on angular readings extending to an elevation angle of 6 degrees, or to elevation and azimuth angles that just clear any object that extends higher than 6 degrees.

EXERCISE (2-3-1)

For items 1 through 5, complete the following statements:

1. **Winds aloft observations are taken to determine the direction and __________ of the winds above the observing station.**
2. **A balloon which is inflated with hydrogen or helium to provide a fixed free lift and tracked visually with a theodolite is known as a __________ observation.**
3. **A balloon which is tracked visually with a theodolite, and the height data are taken from the radiosonde observation is known as a __________ observation.**
4. **A radio transmitter attached to a balloon which is tracked by a radio receiver is known as a __________ observation.**
5. **The limiting-angle zone is regarded as extending __________ degrees in elevation above the horizon.**

OBSERVATIONAL PROCEDURES FOR RAWINS AND RABALS

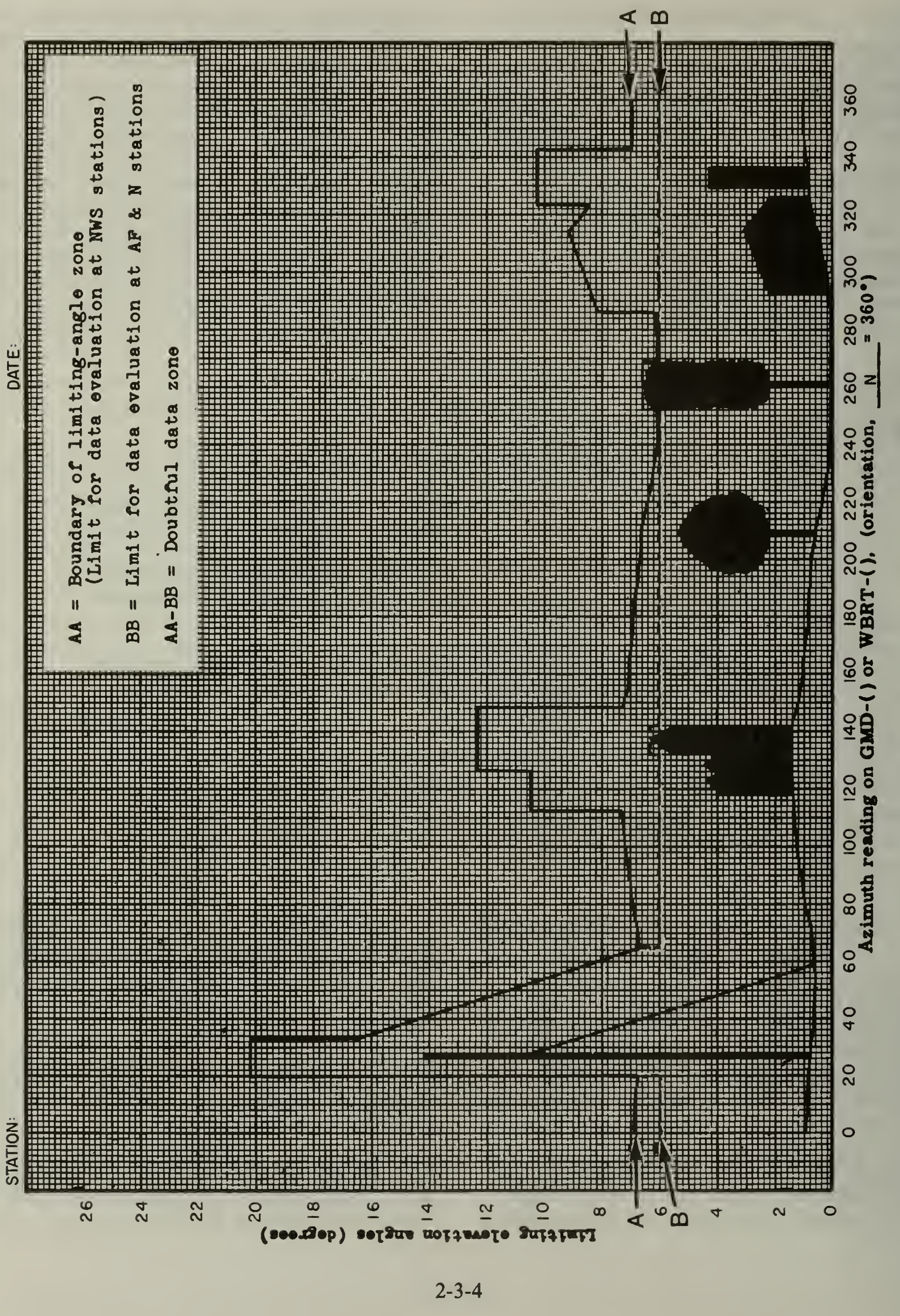
Observational procedures vary on different ships and stations due to the different types of equipment available for the observations. A RAWIN observation may be calculated from any one of the following possible combinations of data:

1. Azimuth, height, and slant range
2. Azimuth, height, and elevation angle
3. Azimuth, slant range, and elevation angle

When search-type radar is used, elevation angles are not determined. Since this information is essential in RAWIN observations, the height of the target must be found in one of the following manners:

1. The balloon reflector must be inflated to a known free lift so that the ascensional rate of the assembly is known.

2. A RAOB must be made simultaneously with the RAWIN so that height data can be determined from the RAOB.



209.99.1

Figure 2-3-1.—Sample limiting-angle diagram for RAWIN set.

RAWIN OBSERVATIONS

Tracking the signal transmitted by the radiosonde (transmitted) is done electronically by the RAWIN set (AN/GMD-1( )). Operational instructions for the AN/GMD-1( ) RAWIN set are found in FMH-3.

Only wind data obtained through automatic tracking of the AN/GMD-1( ) is used in computing winds. Sufficient accuracy cannot be achieved by manual tracking.

Operating Below Limits

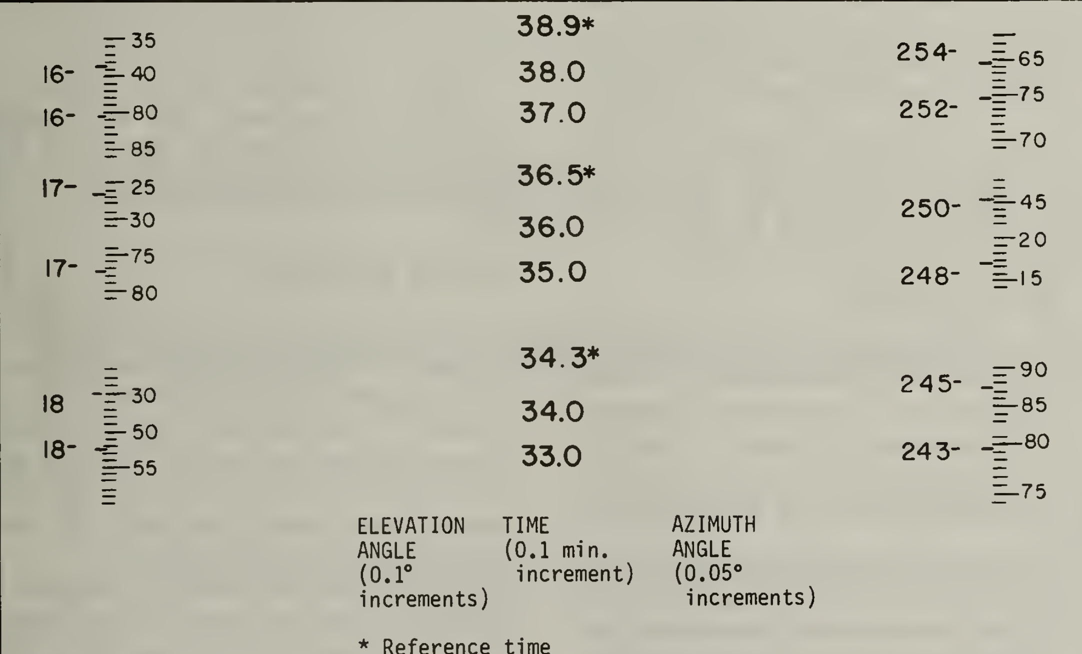
Whenever the transmitter is within visual range, the angular values are below the limiting angles of the RAWIN set used; if cloud and weather conditions permit, continue the observation as a RABAL. See chapter B4 of FMH-3 for instructions.

Record the supplementary RABAL data only so long as the angular readings are equal to or less than the limiting angle. When the angles rise above the critical values, the RAWIN resumes, regardless of the length of missing record.

Rawin Angular Data

At preselected intervals, the control recorder automatically prints on a paper tape simultaneous readings of elevation angle, azimuth angle, and elapsed time (figure 2-3-2). Angular values are printed in increments of 0.01 degree. Beginning with an arbitrary setting of zero at release elapsed time is recorded in terms of minutes and tenths.

Unless instructed to do otherwise, the control recorder is adjusted to print once each minute. When less than 3 minutes are recorded before or



Minute	Elevation angle	Azimuth angle	Minute	Elevation angle	Azimuth angle
33	18.55	243.8	36	17.25	250.5
34	18.30	245.9	37	16.80	252.7
35	17.75	248.2	38	16.40	254.6

Figure 2-3-2.—Sample AN/GMD-1( ) Control recorder tape.

after limiting angles, do not compute winds for those minutes of the flight if you use elevation angles for computing winds.

Reference Time

Record on MF5-20 the elapsed time from release (in minutes and tenths) for the beginning of each reference contact (contacts divisible by 5) between the surface and the 10-mb level. Also do this for each contact at pressures lower than 10 mb. In addition, record the elapsed time for the terminating level, for levels bounding strata of continuous temperature, etc., of sufficient extent to include one or more reference contacts. The elapsed times may be obtained as follows:

- AN/GMD-1( ) recorders are designed so that the elapsed time or the angular values and the elapsed time are printed automatically each time the recorder pen traces a reference contact as indicated by an asterisk beside the print.

- A manual switch or button is provided so that the observer can cause a set of angular values and/or elapsed time to be printed at the beginning of each reference contact, indicated by an asterisk.

- Synchronous motors are used to drive the paper feed on the AN/TMQ-5 recorder. Elapsed time may be obtained by using an appropriate time scale on the recorder Record chart.

RABAL OBSERVATIONS

Normally the balloon-borne radiosonde is tracked by the radio-direction-finding antenna of the AN/GMD-1( ). When the necessary manpower is available to visually track the radiosonde balloon, a RABAL (or a RAWIN continued as a RABAL) will be taken when:

- The automatic tracking ground equipment is inoperative and the RAOB portion of the flight is obtained by manually positioning the antenna in the general direction of the radiosonde.

- When the angular values are expected to go into the limiting-angle zone during the first 10 minutes of the flight.

Timing of Theodolite Readings

When a flight or portion of a flight is to be taken as a RABAL, the theodolite must be set up, leveled, and oriented before the observation. Timing of the theodolite readings must be synchronized with the minutes of RAOB data on the recorder record.

Tracking the Radiosonde Train

For daytime RABAL observations, the cross-hairs of the theodolite is centered on the balloon when minute readings are to be taken. Visual tracking during night observations is facilitated by attaching a PIBAL lighting device to the bottom of the parachute or about 6 feet below the balloon if no parachute is to be used. Follow the safety regulations for use of hydrogen when using a lighting device attached to a hydrogen-filled balloon.

Elevation and azimuth angle readings are taken each minute and read to the same accuracy as a RAWIN observation.

WINDS-ALOFT COMPUTATION SHEET (MF 5-20)

The computation sheet, MF5-20 (figure 2-3-3), is microfilmed; for this reason it is essential that entries on the sheets be made legibly and the sheets be protected from damage.

MF 5-20 ENTRIES

Data are recorded and computed on MF 5-20 for each winds-aloft observation (figure 2-3-3). The computed data is then graphed on a graphing device. The coded data for transmission are extracted from the graph and entered on the MF 5-20. Entries on both sides of the sheet must pertain to the same observation. In some cases more than one sheet is used.

Forms for unscheduled observations are so marked, giving the reason for the observation. This information is entered in a convenient space near the reason for termination. Notations such as Hurricane Special and Tornado Special may be used.

NOTE: Most columns on MF 5-20 are self explanatory, therefore, this section will only cover a few of the columns. For a complete detailed description refer to FMH-5.

DEPARTMENT OF THE NAVY
WINDS ALOFT COMPUTATION SHEET

CONSTANT TIME INTERVALS - WBAN 20H
OPNAV FORM 3140-18 (REV. 10-80) FACE S/N 0107-LF-711-8000

SHIP OR STATION	LAT. & LONG.	ASCENSION	YEAR	MO.	DAY	TIME
NOCD (LAKEHURST, NJ)	40°02'N 74° 19'W	ACTUAL (Local)	1984	4	14	1830
METHOD OF OBSERVATION: RAWINSONDE	EQUIPMENT USED: AN/GMD-1	SCHED. (GCT)	1984	4	14	2330

BALLOON TYPE	STATION ELEVATION	OBSERVER	VERIFIER	ORIENTATION	ASCENSION NO
DA-1200 Gm	25 m	C. J. TESSARO AG3	B. A. ELLIS AG1	360° = NORTH	80

MINUTE PAGE 3	HEIGHT ABOVE SURFACE 30-G BAL. / 100-G BAL.	RAWIN (m) ~~(yds)~~	SLANT RANGE (m) (yds)	ELEVATION ANGLE OBSERVED	ELEVATION ANGLE SMOOTHED	AZIMUTH ANGLE°	CORRECTED AZIMUTH ANGLE A°	CHANGE IN AZIMUTH ΔA°	DISTANCE FROM OBS. POINT O (m) ~~(yds)~~	CHANGE IN DISTANCE ΔD	MINUTE PAGE 1	APPARENT WIND DIRECTION 360° = N	APPARENT WIND SPEED (m.p.s)	SHIP HEADING 360° = N	SHIP SPEED (m.p.s)	TRUE WIND DIRECTION 360° = N	TRUE WIND SPEED (m.p.s)
-	216 / 350	210		36.3			128.2		300		1					313	4.0
-	414 / 670	490		39.2			132.8		480		2					322	5.7
-	612 / 980	780		38.3			138.2		980		3					320	8.4
-	801 / 1295	1050		35.8			137.6		1500		4					310	8.4
-	990 / 1585	1360		36.2			133.6		1800		5					290	6.6
-	1170 / 1880	1680		36.5			128.3		2250		6					279	9.2
-	1350 / 2170	2020		36.1			120.7		2800		7					266	10.1
78	1530 / 2455	2320		35.5			113.5		3250		8					264	12.9
79	1710 / 2740	2650		31.8			107.7		4150		9					271	20.2
80	1890 / 3020	2950		27.7			103.6		5600		10					266	24.5
81	2070 / 3300	3240		24.8			98.8		7000		11					262	26.5
82	2250 / 3580	3520		22.2			96.0		8650		12					269	29.6
83	2430 / 3855	3800		19.80			95.3		10520		13					267	31.6
84	2610 / 4130	4050		17.95			93.4		12450		14					263	35.5
85	2780 / 4405	4300		16.25			91.8		14780		15					269	36.6
86	2970 / 4675	4570		15.00			90.6		16950		16					267	40.6
87	3150 / 4945	4870		13.89			89.4		19650		17					266	44.3
88	3330 / 5215	5210		13.11			88.7		22200		18					266	43.1
89	3510 / 5485	5490		12.33			88.2		24850		19					268	44.7
90	3690 / 5755	5770		11.68	11.70		87.7		27600		20					267	45.0
91	3870 / 6025	6050		11.08	11.14		87.3	-0.5	30300	+5500	21					265	45.5
92	4050 / 6295	6300		10.66	10.64		87.2	-0.3	33100	+7500	22					266	62.1
93	4230 / 6565	6580		10.18	9.70		87.0		37800		23						
94	4410 / 6835	6860		9.69			87.0	-0.2		+5200	24					266	42.0
95	4590 / 7105	7150		9.24	9.29		86.8		43000		25						
96	4770 / 7375	7490		8.93			86.6	-0.4		+6000	26					264	49.7
97	4950 / 7645	7740		8.58	8.60		86.4		49000		27						
98	5130 / 7915	8000		8.30			86.0	-0.9		+7300	28					259	60.8
99	5310 / 8185	8260		8.10	8.08		85.5		56300		29						
100	5490 / 8455	8560		7.85			85.2	-0.5		+7300	30					261	60.6
101	5670 / 8730	8880		7.64	7.67		85.0		63600		31						
102	5850 / 9005	9150		7.51			84.8	-0.3		+5800	32					261	48.1
103	6030 / 9285	9410		7.33	7.42		84.7		69400		33						
104	6210 / 9565	9700		7.43			84.6	-0.7		+10000	34					259	83.2
105	6390 / 9850	9970		6.60	6.81		84.0		79400		35						
106	6570 / 10135	10260		6.41			83.7	-0.6		+9600	36					258	79.8
107	6750 / 10420	10550		6.29	6.35		83.4		89000		37						
108	6930 / 10710	10890		6.34			83.0	-0.5		+76000	38					257	63.2
109	7110 / 11005	11260		6.15	6.20		82.9		96600		39						
110	7290 / 11300	11580		6.10	6.02		82.7	-0.7	101700	+12700	40					258	70.3

RAWINSONDE TIME-ALTITUDE DATA

CONTACT	PRESSURE (mb)	ALTITUDE (m, msl)	ELAPSED TIME (min)
SFC	1018.1	25	0.0
5	1011	70	0.5
10	940	660	2.6
15	872	1270	4.5
20	807	1900	6.6
25	746	2540	8.6
30	688	3200	10.8
35	632	3870	13.1
40	580	4530	15.6
45	529	5230	18.0
50	482	5970	20.5
55	437	6690	23.2
60	392	7460	25.7
65	353	8220	28.7
70	313	9080	31.5
75	280	9800	34.3
80	247	10680	37.4
85	206	11800	41.2
90			
95			

CONTINUED ON REVERSE SIDE

PUNCH CARD DATA

ALT ①	DIRECTION (degrees)	SPEED (mps)	CARD COL.	ALT ①	DIRECTION (degrees)	SPEED (mps)
CARD 1			15	CARD 2		
EQUIP. TYPE		9	16	EQUIP. TYPE		9
SFC	310	3	17/21	7	266	44
150	313	4	22/26	8	259	59
300	316	4	27/31	9	261	54
0.5	319	5	32/36	10	259	82
1.0	311	8	37/41	11	256	64
1.5	286	7	42/46	12		
2.0	270	10	47/51	13		
2.5	266	15	52/56	14		
3	267	24	57/61	15		
4	265	33	62/66	16		
5	266	44	67/71	17		
6	266	45	72/76	18		

CODED DATA FOR TRANSMISSION

72409	PPBB	65004	72409	90012	31006	31016	27020	90346	26547
26564	26587	9078/	26585	26115	91012	26159	25624	26560	9161/
26660	9205/	26663	26198	93057	26123	25730	26260	Ø	
72409	PPCC	6500/	72409	XMTD	Ø				

MAXIMUM WIND SPEED DATA

MIN. ALT. WIND SPEED 45 MPS OR MORE (m)	5960
ALT. OF MAXIMUM WIND SPEED (m)	9650
MAXIMUM WIND SPEED (mps)	83.2
MAX. ALT. WIND SPEED 45 MPS OR MORE (m)	11580

FOOTNOTE: ① Altitude for 150 and 300m are with respect to ground, altitude for other standard levels are in km, msl.

PAGE COUNT: PAGE 1 OF 1 PAGES

Figure 2-3-3.—Entry of data on MF 5-20 (AN/GMD).

209.500

RAWIN Time-Altitude Data

Enter time-altitude data in accordance with the following paragraphs:

CONTACT.—The surface (SFC) to the 140th contact has already been entered. Any contact after the 140th is entered for every fifth contact starting with 145th. An exception to this is after the sounding has reached the pressure of 10 millibars. In this case you enter each contact. The termination and surface contact is entered to the nearest tenth.

PRESSURE.—The pressure is taken from the baroswitch calibration chart furnished with each radiosonde. Enter the pressure values in whole millibars (mb) through 20 mb; the nearest 0.5 mb through 10 mb and the nearest 0.1 mb at pressures less than 10 mb.

ALTITUDE (MSL).—Enter the altitude to the nearest 10 meters above mean sea level (MSL) that corresponds to each of the pressure values. However, the height entered for the surface and termination is entered to the exact meter. These altitude data are taken from the RAOB pressure-altitude curve from the adiabatic charts.

ELAPSED TIME.—Enter the elapsed time, in minutes and tenths, from release to the beginning of each reference contact. The time to termination is also entered on the last line of the column. These times are obtained from the control recorder wind tape as marked by an asterisk.

Height Above Surface

Heights above the surface for both 30- and 100-gram balloons are given in the upper and lower sections of this block.

For RAWINs, enter the height in meters. Station elevation is added to the original heights and then entered to the nearest 10 meters. The heights are obtained from the RAWINSONDE time-altitude curve.

Slant Range

Not used with AN/GMD-1( ) or PIBALs. However, if information is obtained, enter to the nearest 10 meters.

Elevation Angle

Elevation angles are read and recorded for the minutes used for evaluation purposes in accordance with the following:

- To the nearest 0.1 degree whenever the angle is greater than 20 degrees.

- To the nearest 0.05 degree whenever the angle is 20 degrees or less, but more than 15 degrees.

- To the nearest 0.01 degree whenever the angle is 15 degrees or less.

Figure 2-3-2 shows the manner in which values are read or estimated from the control-recorder tape.

Smoothing Elevation Angles

Elevation angles less than 12.0 degrees must be smoothed before being used in wind computations.

Azimuth Angle

Azimuth angles are entered to the nearest 0.1 degree.

Corrected Azimuth Angle

This column is used only for shipboard observations. It is entered to the nearest 0.1 degree.

Change in Azimuth (ΔA)

Enter the change to the nearest 0.1 degree.

Distance From Observation Point

Enter the horizontal distance of the balloon from the observation point for each minute of observation. This distance is obtained from the horizontal distance tables, using the elevation angle and minutes elapsed. Horizontal distance is used on the plotting board only. Enter the value to the nearest 10 meters.

Change in Distance (ΔD)

This column is covered later in this lesson. Enter the change to the nearest 10 meters.

Apparent Wind and Ship Columns

These columns are used in shipboard observations only.

True Wind

The true wind is obtained from the plotting board. Enter the direction to the nearest whole degree and the speed to the nearest meter per second (MPS).

NOTE: The MPS is converted to knots when encoding.

EXERCISE (2-3-2)

For items 1 through 8, complete the following statements:

1. **The AN/GMD-1( ) control recorder automatically prints on a ____________ ____________ simultaneous readings of elevation angle, azimuth angle, and elapsed time at preselected intervals.**
2. **A reference time is printed on the control recorder tape for selected reference contact points and is indicated by an ____________ beside the print.**
3. **When you enter the "Time-Altitude Data" onto the MF5-20, the PRESSURE is taken from the ____________ calibration chart.**
4. **For a RAWIN observation, the height above the surface is entered on the MF5-20 to the nearest ____________ meters.**
5. **When entering the elevation angles onto the MF5-20 and the angle is 20 degrees or less, but more than 15 degrees, the angle value is entered to the nearest ____________ degree.**
6. **Elevation angles must be smoothed on the MF5-20 when the angles are less than ____________ degrees.**
7. **All azimuth angles on the MF5-20 are entered to the nearest ____________ degree.**
8. **All distance from the observation point on the MF5-20 are entered to the nearest ____________ meters.**

EVALUATION OF THE RAWIN OBSERVATION

Winds aloft observations are evaluated by using the elevation angles and height above the surface of the balloon to obtain a horizontal distance out (HDO). The HDO is then plotted against the azimuth angle onto a plotting board showing the path of the balloon. By measuring the displacement of these balloon points over a given interval of time will give you the wind direction and speed.

NOTE: For a complete description of the procedures used in evaluating the winds aloft refer to FMH-5.

PIBAL OBSERVATION

In a PIBAL observation, a small, gas-filled balloon is tracked visually by means of a theodolite as it rises into the atmosphere. Angular bearings of the balloon are taken and recorded for each minute of the flight. The balloon is inflated to rise with a predetermined and constant ascension rate. The angular values read from the theodolite are used in conjunction with the assumed ascension rate of the balloon to compute directions and speeds of the winds aloft. Tracking the balloon during a night observation is done by attaching a small, battery-powered lighting unit to the balloon.

LAND STATION PIBALS

The evaluation of land station PIBALs requires projecting the path of the balloon to a horizontal plane tangent to the surface of the earth. The evaluation requires the determination of the altitude and horizontal distance of the balloon (distance balloon traveled from the point of observation). The evaluation should also include the data obtained during the actual observation.

Since the rate of ascension of the pilot balloon is assumed to be fixed, it is not necessary to compute the heights above the surface for the minute intervals corresponding to the observed data. In both 30- and 100-gram balloons, height data used in PIBAL computations are printed in the column headed "Height above surface," MF 5-20 (figure 2-3-4).

Selection of a Theodolite Site

The site of the observing equipment is regarded as the point of observation. The point of observation is selected with a view to reducing to a minimum the probability of loss of data due to fixed obstructions such as buildings, trees, and towers.

Angular altitudes of obstructions around theodolite sites should not exceed 6 degrees above the horizontal plane (an exception—small pipes or masts). Avoid proximity to chimneys. Slight amounts of smoke are sufficient to obscure the balloon and are a source of annoyance to observers. If a single suitable site that satisfies these requirements and that is convenient to the observatory cannot be found, alternate theodolite points of observation may be established for use under various conditions of wind. For instance, with a westerly wind, interference presented by a tall central structure on a roof may be avoided by establishing a point of observation at the eastern edge of the roof.

Theodolite Description

The land stations type of theodolite (figure 2-3-5) is similar in many respects to a surveyor's transit (with certain modifications necessary to adapt it to PIBAL work).

The theodolite is used to obtain the azimuth and elevation angles of the balloon. These angles are read to the nearest one-tenth of a degree.

TELESCOPE.—The telescope is supported over the center of the upper plate by a yoke standard. It is mounted in a manner that allows it to be rotated in both the vertical and horizontal planes. It can be turned on a horizontal axis passing through the center of the vertical circle. It can also be revolved about a vertical axis passing through the center of the horizontal circle. The theodolite telescope differs from the transit telescope in that the line of sight in the theodolite is bent through an angle of 90 degrees.

This theodolite has an adjustable focus and must be refocused each time the theodolite is used, usually several times during the course of an observation.

BALLOONS

All pilot balloons used in taking winds-aloft observations are spherically shaped films of natural or synthetic rubber (neoprene), which are inflated with lighter-than-air gas (hydrogen or helium). The film thickness of the inflated balloons is extremely small and the balloons are very delicate. The smallest cut, bruise, or scratch sustained during storage or preflight preparations could seriously affect the altitude at which the balloon bursts. Emphasis must be placed on the requirement for careful handling of the balloons.

DEPARTMENT OF THE NAVY
WINDS ALOFT COMPUTATION SHEET

CONSTANT TIME INTERVALS - WBAN 20M
OPNAV FORM 3140-18 (REV. 10-58) FACE S/N 0107-LP-711-8000

SHIP OR STATION	LAT & LONG	ASCENSION	YEAR	MO	DAY	TIME
NOCD (LAKEHURST, N.J.)	40° 02'N 74° 19'W	ACTUAL (Local)	1984	9	14	1838
METHOD OF OBSERVATION: PIBAL	EQUIPMENT USED: THEODOLITE	SCHED. (GCT)	1984	9	14	2338

BALLOON TYPE	STATION ELEVATION	OBSERVER	VERIFIER	ORIENTATION	ASCENSION NO
100-GRAM	25m	J. W. SATTERFIELD AG3	W. M. TUNGATE AG1	360° = NORTH	33

MINUTE PAGE 3	HEIGHT ABOVE SURFACE 30-G BAL. / 100-G BAL.	HEIGHT ABOVE SURFACE RAWIN (m) (yds)	SLANT RANGE (m) (yds)	ELEVATION ANGLE OBSERVED	ELEVATION ANGLE SMOOTHED	AZIMUTH ANGLE°	CORRECTED AZIMUTH ANGLE A°	CHANGE IN AZIMUTH ΔA°	DISTANCE FROM OBS. POINT D (m) ~~(yds)~~	CHANGE IN DISTANCE ΔD	MINUTE PAGE 1	APPARENT WIND DIRECTION 360° = N	APPARENT WIND SPEED (m.p.s)	SHIP HEADING 360° = N	SHIP SPEED (m.p.s)	TRUE WIND DIRECTION 360° = N	TRUE WIND SPEED (m.p.s)
-	210 / 350			27.4		55.5			680		1					240	11.9
-	414 / 670			24.7		60.2			1460		2					243	12.1
-	612 / 980			26.7		60.6			2130		3					232	10.9
-	801 / 1285			24.9		56.3			2770		4					227	11.2
-	990 / 1595			24.6		55.3			3460		5					235	11.0
-	1170 / 1880			24.7		56.0			4090		6					247	7.6
-	1350 / 2170			26.4		57.8			6370		7					255	8.6
78	1530 / 2455			25.8		59.8			5080		8					255	10.9
79	1710 / 2740			26.0		61.7			5620		9					260	9.3
80	1890 / 3020			26.1		63.3			6170		10					266	8.2
81	2070 / 3300			26.7		65.2			6560		11					272	8.3
82	2250 / 3580			27.0		67.3			7030		12					270	8.6
83	2430 / 3855			27.3		68.7			7500		13					270	7.5
84	2610 / 4130			27.7		70.0			7870		14					278	7.0
85	2790 / 4405			28.1		71.5			8250		15					277	7.6
86	2970 / 4675			28.3		72.7			8680		16					271	8.2
87	3150 / 4945			28.6		73.7			9190		17					272	7.8
88	3330 / 5215			28.9		74.7			9570		18					281	7.2
89	3510 / 5485			29.0		76.0			9940		19					286	7.8
90	3690 / 5755			29.1		77.4			10380		20					284	8.2
91	3870 / 6025			29.1		78.5			10820		21					278	8.0
92	4050 / 6295			28.9		78.6			11310		22					260	8.7
93	4230 / 6565			29.0		79.1			11890		23					266	8.5
94	4410 / 6835			29.3		79.3			12330		24					278	6.9
95	4590 / 7105			29.7		79.9			12660		25						
96	4770 / 7375			30.4		80.7					26					309	4.7
97	4950 / 7645			31.0		81.8			13030		27						
98	5130 / 7915			31.5		82.9					28					279	2.9
99	5310 / 8185			31.7		83.6			13360		29						
100	5490 / 8455			31.9		84.1					30					269	5.7
101	5670 / 8730			31.8		84.5			14030		31						
102	5850 / 9005			31.7		85.2					32					271	8.3
103	6030 / 9285			31.6		85.9			15030		33						
104	6210 / 9565			31.4		86.5					34					272	9.3
105	6390 / 9850			31.4		86.9			16140		35						
106	6570 / 10135			31.3		87.4					36					275	8.5
107	6750 / 10420			31.3		88.0			17140		37						
108	6930 / 10710			31.3		87.9					38					264	8.0
109	7110 / 11005			31.3		87.5			18100		39						
110	7290 / 11300			31.3		87.3					40					261	7.6

RAWINSONDE TIME-ALTITUDE DATA

CONTACT	PRESSURE (mb)	ALTITUDE (m, msl)	ELAPSED TIME (min)
SFC			
5			
10			
15			
20			
25			
30			
35			
40			
45			
50			
55			
60			
65			
70			
75			
80			
85			
90			
95			

CONTINUED ON REVERSE SIDE

PUNCH CARD DATA

ALT ①	DIRECTION (degrees)	SPEED (mps)	CARD COL	ALT ①	DIRECTION (degrees)	SPEED (mps)
CARD 1			15	CARD 2		
EQUIP. TYPE		1	16	EQUIP. TYPE		1
SFC	230	11	17/21	7	296	6
150	235	12	22/26	8	273	3
300	239	12	27/31	9	272	8
0.5	241	12	32/36	10	268	7
1.0	237	11	37/41	11		
1.5	229	8	42/46	12		
2.0	249	8	47/51	13		
2.5	255	11	52/56	14		
3	264	8	57/61	15		
4	271	7	62/66	16		
5	272	8	67/71	17		
6	277	7	72/76	18		

CODED DATA FOR TRANSMISSION

72409	PPBB	65001	72409	90012	23022	23522	25016	90346	26516
27014	27514	90789	29512	27506	27016	91246	27017	27515	27015
9205/	28016	30008	93057	27016	26516	26015	Ø		
72409	PPCC	6500/	7249	XMTD	Ø				

MAXIMUM WIND SPEED DATA

MIN ALT. WIND SPEED 45 MPS OR MORE (m)	
ALT. OF MAXIMUM WIND SPEED (m)	670
MAXIMUM WIND SPEED (mps)	12.1
MAX ALT. WIND SPEED 45 MPS OR MORE (m)	

FOOTNOTE: ① Altitude for 150 and 300m are with respect to ground; altitude for other standard levels are in km, msl.

PAGE COUNT: PAGE 1 OF 1 PAGES

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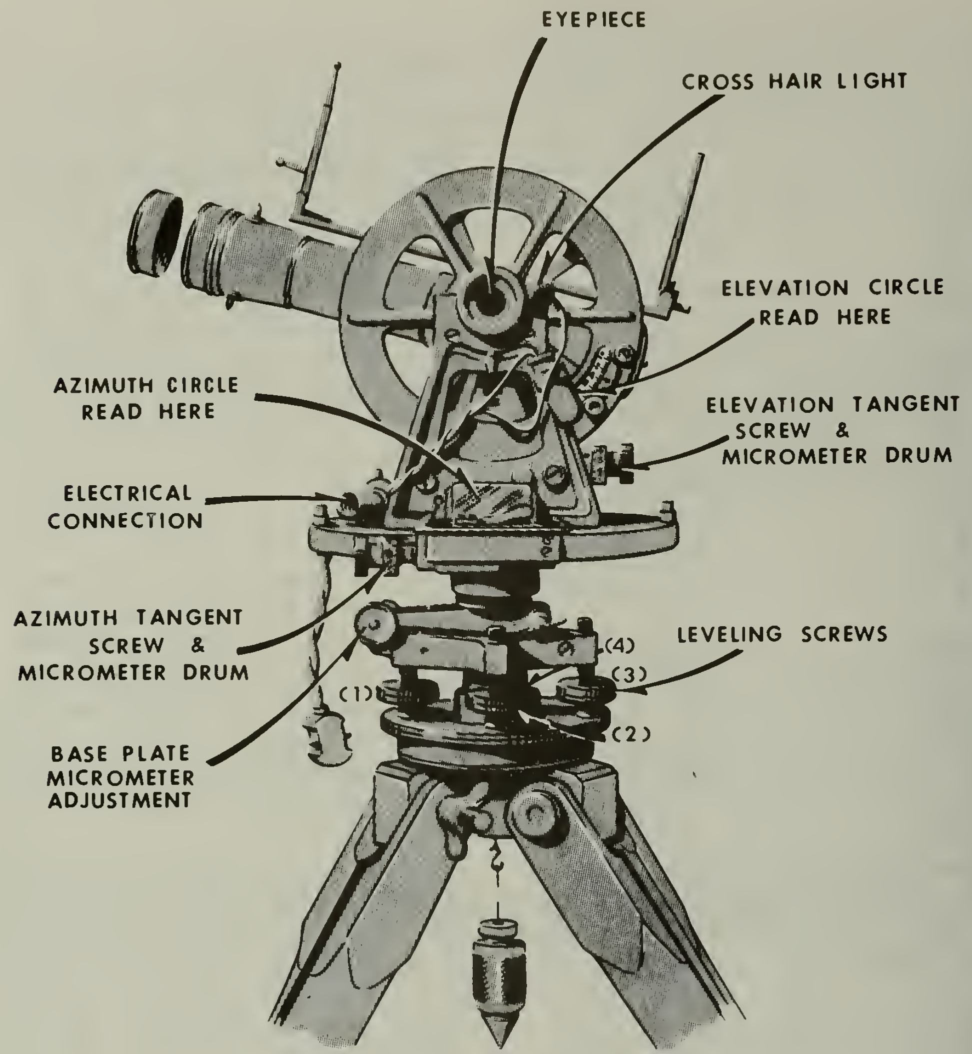
Figure 2-3-4.—Entry of data on MF 5-20 (Theodolite).

209.501



209.99

Figure 2-3-5.—Shore-type theodolite (ML-474).

A 100-gram balloon is used for daytime scheduled PIBAL that is expected to reach 7 kilometers or more above the surface. A 30-gram balloon is used for all other scheduled PIBALs, except that a 100-gram balloon is used instead whenever strong winds in the lower levels make it probable that a 30-gram balloon would be blown out of sight before reaching the cloud layer.

Storage and Handling

Balloons must be stored in their original sealed containers and in a warm room at temperatures not to exceed 120 °F. They should not be placed immediately adjacent to large electric generators or motors because these create ozone. Ozone is detrimental to neoprene. Since balloons deteriorate with age, they should be used in the order of their production dates to avoid excessive aging. If balloons must be stored at below-freezing temperatures, they must be returned to a temperature of 65 °F (or higher) for a period of 12 hours or more before being removed from their containers. This practice helps to avoid any damage that they might receive when removed from containers and unfolded while cold. No

Table 2-3-1.—Pilot balloon inflation nozzle and weights

	Day		Night	
	Helium	Hydrogen	Helium	Hydrogen
100-gram	515 grams (total)	450 grams (total)	Use 30-gram balloons only.	
	Universal Balloon Balance—Selected components plus 200- or 300-gram hooked weight and analytical weights as required. Or Radiosonde Inflation Kit MK-2161 grams			
	450-gram nozzle plus 65-gram added weight.	450-gram nozzle.		
30-gram	139 grams (total)	125 grams (total)	192 grams. Attach lighting unit after inflation.	170 grams. Attach lighting unit after inflation.
	Universal Balloon Balance—Selected components plus analytical GM weights as required.			

part of the balloon except the neck should be touched with the bare hands. When it is necessary to handle any portion other than the neck, use soft rubber gloves, soft cloth gloves, or some other nonabrasive material.

Color of the Balloon

The choice of color is to some extent a matter for the individual to decide. In general, a *white* balloon is satisfactory for use with a clear sky, a *black* balloon with low or middle overcast, and a *red* balloon with high overcast or with a white or gray background. Usually when haze, dust, or smoke is present in a cloudless sky, a white balloon remains visible longest. This is true because the sun shining upon it above a lower layer of haze creates scintillation that is absent when colored balloons are used.

Inflating the Pilot Balloon

A balloon made of neoprene is more resilient when warm. For this reason inflate, whenever possible, in a room with a temperature greater than 60°F. When extended, rubber is subject to fatigue which causes balloons to burst at low altitudes. For this reason and to reduce the loss of gas by diffusion, delay the inflation until just before the observation is to begin. Select the counterweights specified in table 2-3-1 appropriate to the balloon and attach them to the nozzle. The balloon is correctly inflated when it is just buoyant enough to float with the counterweights and inflation nozzle attached.

Lighting Units

Tracking a night PIBAL is made possible by attaching a lightweight, battery-operated lighting unit to the balloon. The unit consists of a water-activated battery and a low-current lamp. Several lighting units are packed in a sealed metal container, together with pads of insulating material and a dehydrating agent. These units have an indefinite shelf life when stored in the original sealed containers. Do not open the containers until the units are needed.

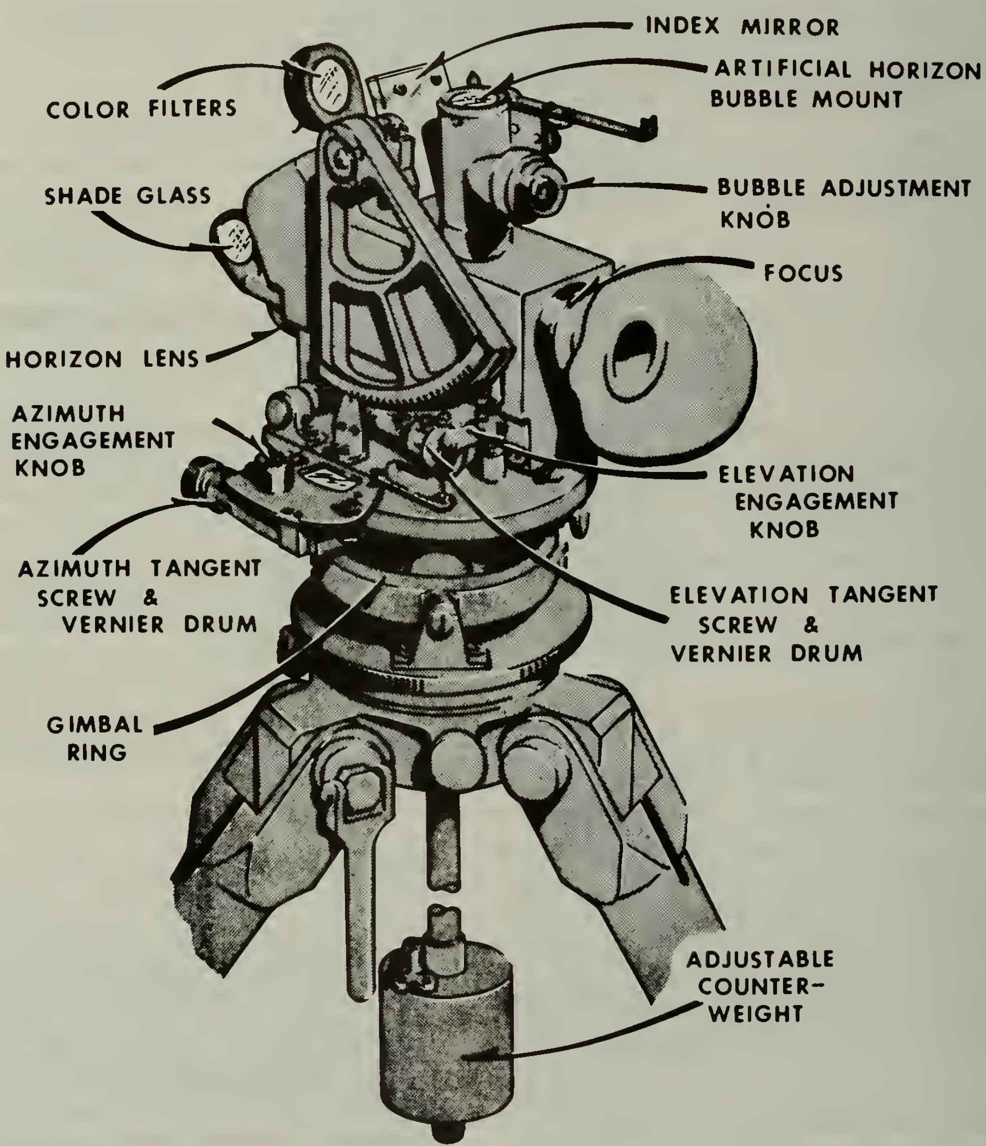
Carefully reseal the containers after each lighting unit is removed.

No lighting unit should be used for a release made more than 15 minutes after the unit had been activated; the lighting unit should be activated just prior to the release. Activate this unit in accordance with accompanying instructions. The procedures may differ slightly with manufacturers.

NOTE: The procedures for tracking and evaluation can be found in FMH-5.

MARINE (SHIPBOARD) WINDS ALOFT OBSERVATIONS

Advances in radar tracking equipment, coupled with the computer, have made marine winds aloft observations faster and more accurate.



209.100

Figure 2-3-6.—Shipboard theodolite.

This combination will give wind speed (knots) and wind direction (true) for any time increments or any height as required. It eliminates the need for the hand plotting and graphing.

NOTE: The procedures for Marine winds aloft observations can be found in FMH-5.

Shipboard Theodolite

Shipboard PIBALs are taken by tracking a PIBAL balloon visually by means of a marine theodolite (figure 2-3-6). Elevation and azimuth angle readings are taken each minute. They are used in conjunction with height data based on the assumed rate of the ascending balloon.

The theodolite is designed for mounting in the gimbal head of a tripod. This theodolite is not leveled in the manner of a land-type. Instead, a counterweight is moved up or down on a shaft until the counterweight holds the theodolite in as nearly a vertical position as possible.

Plotting and Graphing Boards

The plotting and graphing procedures for RAWINs and RABALs are the same as the PIBALs method.

EXERCISE (2-3-3)

For items 1 through 5, complete the following statements.

1. **To determine the wind direction and speed, you must plot the HDO along with the corresponding ___________ angle.**

2. **PIBAL observation rate of ascent is assumed to be fixed; therefore, the height above the surface for the minute intervals corresponding to the observed data are printed on the MF5-20 for both the 30 gram and ___________ gram balloons.**

3. **A land station theodolite is used to obtain the azimuth and elevation angles of the balloon; these angles are read to the nearest ___________ of a degree.**

4. **The shipboard theodolite is equipped with a ___________ that can be moved up or down on a shaft until the theodolite is in as nearly a vertical position as possible.**

UNIT 3

CODES AND PLOTTING

FOREWORD

This unit introduces you to the weather codes that are used in plotting various weather data on charts and graphs.

There are nine lessons in this unit. Lesson 1 covers *Surface Synoptic Reports*. Lesson 2 covers *Plotting Surface Charts*. Lesson 3 covers *Plotting Skew-T, Log P Diagram*. Lesson 4 covers *Plotting Upper Air Reports*. Lesson 5 covers *Plotting Sea Surface Temperatures*. Lesson 6 covers *Plotting Satellite Tracks*. Lesson 7 covers *Plotting Radiological Fallout Predictions*. Lesson 8 covers *Upper Air Reports*. Lesson 9 covers *Winds Aloft Reports*.

UNIT 3—LESSON 1

SURFACE SYNOPTIC REPORTS

OVERVIEW

Decode and Encode Surface Synoptic Reports.

OUTLINE

Land Synoptic Reports

Ship Synoptic Reports

LAND SYNOPTIC REPORTS

The word "synoptic" means, in general, pertaining to or affording an overall view. Synoptic observations are periodic (3-hourly or 6-hourly) observations which describe the overall weather conditions existing at the observing stations. The implication here is that they are complete weather observations. The synoptic code, therefore, is a code by which synoptic weather observations are communicated. Synoptic weather observations are, in turn, plotted on synoptic charts for the forecaster's use.

Learning Objective: Recognize the procedures for decoding and encoding surface synoptic reports.

WORLD METEOROLOGICAL ORGANIZATION

Meteorological codes are international in scope and use. Basically, all the codes are the same the world over. They have been devised and agreed upon by the World Meteorological Organization (WMO). This organization is an affiliate of the United Nations and its function is primarily to coordinate meteorological matters between the members.

Much standardization in meteorological matters—including meteorological codes—has been achieved. However, there are some regional or national exceptions to the general rules. For this reason, meteorological codes are defined in terms of the WMO regions.

The WMO has subdivided the world into Regions I through VI and the Antarctic. This is to accommodate the individual needs and interests of various geographical areas. Not all of the various regions include the same sections of the synoptic code; therefore, to become familiar with the various regional synoptic code formats, refer to FMH-2.

SYMBOLIC FORMAT

Synoptic codes are composed of groups of symbolic letters arranged in a specific sequence. Each letter or group of letters has a meaning within the group, and each group has a meaning within the code. For the most part, decoding

and coding are a matter of substituting the correct values for the symbolic letters. This is usually done with the synoptic code tables.

The following coverage on the synoptic code is limited to the symbolic code form. For a complete listing of the specifications of these letters, refer to the FMH-2.

The following symbolic format shows the maximum number of data groups. Very few reports use all of the groups.

$M_iM_iM_jM_j$ $YYGGi_w$ IIiii i_Ri_xhVV Nddff $1s_nTTT$ $2s_nT_dT_dT_d$ $3P_oP_oP_oP_o$ 4PPPP 5appp $6RRRt_R$ $7wwW_1W_2$ $8N_hC_LC_MC_H$ 9hh// 333 $1s_nT_xT_xT_x$ $2s_nT_nT_nT_n$ $7R_{24}R_{24}R_{24}R_{24}$ $8N_sch_sh_s$ $9S_pS_ps_ps_p$

$M_iM_iM_jM_j$

The first group, is not included in the report that you send from your station, but is added on later when your report is put into a bulletin with other reports. In a bulletin of reports from land stations, **$M_iM_iM_jM_j$** is always encoded as AAXX.

$YYGGi_w$

The second group, is not included in the report that you send from your station but is added on later when your report is put into a bulletin with other reports.

YY is the day of the month for the scheduled time of the observation, in GMT.

YY is always encoded as a two-digit number. On the first day of the month YY is encoded as 01; on the second day YY is encoded as 02; and so on to the end of the month.

GG is the scheduled time of observation (in whole hours) in GMT.

In a bulletin of main synoptic observations GG is always encoded as 00 or 06 or 12 or 18, depending on the scheduled time of the observations.

In the bulletin of intermediate synoptic observations GG is always encoded as 03 or 09 or 15 or 21, depending on the scheduled time of the observations.

i_w is the wind indicator. Refer to WMO or FMH-2 code table 1855.

IIiii

This is the only one of the three groups that you should include in your report. It is always the first group in the report that you send from your station. This group is called the international index number.

II designates the block number. Block numbers are assigned to individual countries by the WMO. Block numbers (II) are allocated to countries or geographical areas (72 and 74 for United States and Canada respectively). Each of the Block numbers can identify up to 1000 station numbers (iii).

iii designates the station number. Station numbers are assigned by the individual countries. The station numbers are printed on the weather maps right below the small circle that identifies the position of the particular weather station.

i_Ri_xhVV

This fourth group must be included in all reports from manned stations.

i_R is an indicator for inclusion or omission of precipitation data (Group 6). Refer to WMO or FMH-2 code table 1819.

i_x is an indicator for the type of station operation and for past and present weather (Group 7). Refer to WMO or FMH-2 Code Table 1860.

h is used to report the height above the ground of the base of the lowest cloud seen. If the bottom of the cloud has variable heights, then report the lowest part of the cloud for h. Refer to WMO or FMH-2 Code Table 1600.

VV is the horizontal surface visibility. Refer to WMO or FMH-2 Code Table 4377.

EXERCISE (3-1-1)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

TERM	DEFINITION
1. ________ $M_iM_iM_jM_j$	a. Indicator for inclusion or omission of precipitation group 6
2. ________ YY	b. Horizontal surface visibility
3. ________ GG	c. AAXX is always encoded for a land station bulletin report
4. ________ i_w	d. Wind indicator
5. ________ II	e. Station number
6. ________ iii	f. Day of the month
7. ________ i_R	g. Indicator for type of station operation for weather group 7
8. ________ i_x	h. Block number
9. ________ i	i. Height above the ground of the base of the lowest cloud seen
10. ________ VV	j. Time of the observation in GMT

Nddff

This group must be included on all reports from manned stations. If any of the information is missing, encode a solidus (/).

N is the total cloud cover or the fraction of the celestial dome covered by clouds. Refer to WMO or FMH-2 Code Table 2700.

dd represents surface wind direction in increments of ten degrees starting with ten. Wind direction is the direction from which the wind is coming. Refer to WMO or FMH-2 Code Table 0877 to convert a reading in whole degree increments of ten degrees. If the wind is calm, report dd as 00. Wind direction is always encoded in two digits.

ff represents surface wind (wind in knots). If the wind speed is 1-99 knots, then the actual wind speed is encoded as indicated. For wind speeds of 100 knots or more, decode or encode ff as ff minus 100 and add 50 to the encoded value for dd. For example, a 112 knot wind from 230 degrees is encoded as ddff = 7312.

$1s_nTTT$

This group reports the air temperature.

1 indicates that air temperatures follow.

s_n is used to indicate whether the temperature is positive or negative. Refer to WMO or FMH-2 Code Table 3845.

TTT is the air temperature to a tenth of degree Celsius. Always encode TTT as a three-digit number. For example, an air temperature of 23.4°C is encoded as 234.

$2s_nT_dT_dT_d$

This group reports the dew point temperature.

2 indicates that dew point temperature follows.

s_n is used and means the same as in the air temperature group above.

$T_dT_dT_d$ is used and means the same as in the air temperature group above.

$3P_oP_oP_oP_o$

This group reports the station pressure.

3 indicates that station pressure follows.

$P_oP_oP_oP_o$ contains the station pressure in tenths of a hectopascal. Station pressure in the reading from your barometer (converted to hectopascals if necessary). If station pressure is 999.9 hectopascals or less, then encode that value for $P_oP_oP_oP$ as 9999. If the station pressure is 986.4 hectopascals, then $3P_oP_oP_oP_o$ = 39864. If station pressure is more than 999.9 hectopascals, drop the thousandth value of the pressure and encode what is left for $P_oP_oP_oP_o$. For example, if the station pressure is 1016.7 hectopascals, then $3P_oP_oP_oP_o$ = 30167. If, for any reason, you do not have a station pressure, then leave the entire group out of your report.

EXERCISE (3-1-2)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

TERM	DEFINITION
1. ________N	a. Wind speed
2. ________dd	b. Indicator for station pressure
3. ________ff	c. Air temperature
4. ________1	d. Total cloud cover
5. ________s_n	e. Indicates whether the temperature is positive or negative
6. ________TTT	f. Wind direction
7. ________2	g. Dew point temperature
8. ________$T_dT_dT_d$	h. Indicator for dew point temperature
9. ________3	i. Indicator for air temperature group
10. ________$P_oP_oP_oP_o$	j. Station pressure

4PPPP

This group reports the sea level pressure.

4 indicates that sea level pressure follows.

PPPP contains the sea level pressure, in tenths of hectopascals. The same rules used for the 3-indicator group are used to encode the 4-indicator group. For example, if sea level pressure is 996.1 hectopascals, then encode

4PPPP as 49961. If sea level pressure is 1037.8 hectopascals, then encode 4PPPP as 40378.

5appp

This group is the 3-hour pressure tendency and pressure change.

5 indicates that a 3-hour pressure tendency and pressure change follow.

a is the character of the pressure tendency during the 3 hours preceding the time of observation. Refer to WMO or FMH-2 Code Table 0200.

ppp is the actual change in the pressure during the 3 hours ending at the actual time of the observation. Always use three digits to encode pressure change. For example, if pressure change is 10.3 hectopascals, then encode ppp as 103; if the pressure change is 8.2 hectopascals, then encode ppp as 082.

If for any reason, the amount of pressure change is unknown, but neither the characteristic nor the amount of pressure change is available, leave the entire group out of the report.

6RRRt$_R$

This group reports the amount of precipitation.

6 indicates that the precipitation amount follows.

RRR is the total amount of precipitation during the period. This is the actual amount of liquid precipitation or the water equivalent of solid precipitation. Precipitation is reported in millimeters. Refer to WMO or FMH-2 Code Table 3590.

t$_R$ is the length of time covered by the 6RRRt$_R$ group. It is reported in increments of six hours ($t_R = 1$ indicates 6 hours, $t_R = 2$ indicates 12 hours, etc., ending at the actual time of the observation).

EXERCISE (3-1-3)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

TERM	DEFINITION
1. __________ 4	a. Length of time
2. __________ PPPP	b. Indicator for sea level pressure
3. __________ 5	c. Indicator for 3-hour pressure change
4. __________ appp	d. Precipitation amount
5. __________ 6	e. Indicator for amount of precipitation
6. __________ RRR	f. Sea level pressure
7. __________ t_R	g. Pressure tendency and amount of change

7wwW$_1$W$_2$

This group includes information about the weather at the time of the observation, and the past weather since the last main synoptic observation.

7 indicates the significant present weather and significant past weather follow.

ww contains the code for the present weather at the time of observation. Refer to WMO or FMH-2 Code Table 4677. If there is more than

one code number that is applicable to ww, the higher code number is selected with the exception that code number 17 (thunderstorms without precipitation) takes precedence over code numbers 20 to 49.

W_1W_2 is encoded to depict the past weather over the past 3 or 6 hours. Refer to WMO or FMH-2 Code Table 4500. For the 0300, 0900, 1500 and 2100 observations, W_1W_2 is the past weather for the previous 3 hours, and at 0000, 0600, 1200 and 1800 the previous 6 hours. The complete indicator group (7) should normally be encoded to show the most complete weather picture possible for the appropriate time period. Normally W_1 and W_2 are encoded with different code numbers; however, if the weather has not changed for the past 3 or 6 hours, W_1 and W_2 have the same code number.

$8N_hC_LC_MC_H$

This group is used to report clouds at the time of the observation.

8 is the indicator for the cloud group of the report.

N_h may be either the *total* amount of C_L (low) clouds, or the total amount of C_M (middle) clouds when no low clouds are present. Refer to WMO or FMH-2 Code Table 2700. Never encode N_h for C_H (high) clouds.

$C_LC_MC_H$ is used to code the principal types of low, middle, and high clouds. For low clouds (C_L), refer to WMO or FMH-2 Code Table 0513 to encode and decode C_L. To encode and decode middle clouds (C_M) and high clouds (C_H), refer to WMO or FMH-2 Code Tables 0515 and Code Table 0509, respectively. The priority for encoding $C_LC_MC_H$ is to encode the highest applicable code number.

9hh//

This group is used to report the base of the low cloud.

9 is the indicator for the base of the low cloud group.

hh is included only when the height of the low cloud is to be reported to the nearest 30 meters.

// is used only as a filler.

EXERCISE (3-1-4)

Match the correct definitions with each term. Enter the number of the definition on the line preceding the term.

TERM	DEFINITION
1. ________ 7	a. Indicator for height of low cloud
2. ________ ww	b. Indicates part of group is missing or not used
3. ________ W_1W_2	c. Height of low cloud
4. ________ 8	d. Indicator for present and past weather
5. ________ N_h	e. Past weather
6. ________ C_L	f. Total amount of low clouds
7. ________ C_M	g. Type of middle cloud
8. ________ C_H	h. Present weather
9. ________ 9	i. Type of high cloud
10. ________ hh	j. Type of low cloud
11. ________ //	k. Indicator for cloud group

333

This group of the synoptic code is used to send information that is needed within a particular WMO Region, but that is not needed outside of the Region. The groups in Section 3 that begin with identifiers 1, 2, 3, 4, 5, 8, and 9 are standard in format in all the regions; however, not all of the groups are used in all of the regions.

$1s_nT_xT_xT_x$

This group is used to report maximum temperature.

1 is the indicator for the maximum temperature group.

s_n is used to indicate whether the temperature is positive or negative. Refer to WMO or FMH-2 Code Table 3845.

$T_xT_xT_x$ is used to report the past maximum temperature. Entered the same as TTT.

$2s_nT_nT_nT_n$

This group is used to report minimum temperature.

2 is the indicator for the minimum temperature.

s_n is used to indicate whether the temperature is positive or negative. Refer to WMO or FMH-2 Code Table 3845.

$T_nT_nT_n$ is used to report the past minimum temperature. Entered the same as TTT.

$7R_{24}R_{24}R_{24}R_{24}$

This group is used to report the past 24-hour precipitation amount.

7 is the indicator for the 24-hour precipitation amount.

$R_{24}R_{24}R_{24}R_{24}$ is the precipitation amount in tenths of a millimeter. Always encode $R_{24}R_{24}R_{24}R_{24}$ in four digits. For example, if the amount was 12.3 millimeters, you encode $R_{24}R_{24}R_{24}R_{24}$ as 70123. If there was no precipitation whatsoever during the 24-hour period, encode 70000. If there was only a trace of precipitation, encode 79999. Refer to WMO or FMH-2 Code Table 3590.

$8N_sch_sh_s$

This group is included only in reports from manned stations in WMO Regions IV and V that do not transmit hourly observations.

8 is the indicator for the cloud layer group.

N_s is the amount of the individual cloud layer reported by that group. Refer to WMO or FMH-2 Code Table 2700.

C is the cloud type for that layer. Refer to WMO or FMH-2 Code Table 0500.

h_sh_s is the height above the ground of the cloud layer. Refer to WMO or FMH-2 Code Table 1677.

$9S_pS_ps_ps_p$

This group is used to report special phenomena. It is used only for selected groups at stations in Region IV.

9 is the indicator for the special phenomenon group.

S_pS_p is the code for a particular phenomenon.

s_ps_p is the code used to encode the value of the phenomenon given by S_pS_p. The inclusion of the different types of phenomenon for this group is beyond the scope of this manual. Full details are contained in FMH-2.

EXERCISE (3-1-5)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

TERM	DEFINITION
1. ________ 333	a. Past minimum temperature
2. ________ s_n	b. Amount of cloud layer reported by that group
3. ________ $T_xT_xT_x$	c. Indicate whether the temperature is positive or negative
4. ________ $T_nT_nT_n$	d. Height of cloud reported by that group
5. ________ $7R_{24}R_{24}R_{24}R_{24}$	e. Special phenomena group
6. ________ N_s	f. Special information needed within a particular WMO region
7. ________ C	g. Type of cloud for that layer
8. ________ h_sh_s	h. Past maximum temperature
9. ________ $9S_pS_ps_ps_p$	i. Past 24-hour precipitation amount

SHIP SYNOPTIC REPORT

The contents of the ship's synoptic report are very similar to those of the land synoptic report. The only differences are in reporting position, time, and certain information relating to the sea. The synoptic form of the ship's synoptic report is as follows:

$M_iM_iM_jM_j$ DDDD $YYGGi_w$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ i_Ri_xhVV Nddff $1s_nTTT$ $2s_nT_dT_dT_d$ 4PPPP 5appp $7wwW_1W_2$ $8N_hC_LC_MC_H$ 9hh// $222D_sV_s$ $0s_nT_wT_wT_w$ $2P_wP_wH_wH_w$ $3d_{w1}d_{w1}d_{w2}d_{w2}$ $4P_{w1}P_{w1}H_{w1}H_{w1}$ $5P_{w2}P_{w2}H_{w2}H_{w2}$ $6I_sE_sE_sR_s$ ICE $c_iS_ib_iD_iz_i$

$M_iM_iM_jM_j$

The first group is not included in the report that you send from your ship, but is added when your report is put into a bulletin with other reports. In a bulletin of reports from ships, $M_iM_iM_jM_j$ is always encoded as BBXX.

DDDD

DDDD is only used to encode a ship's call letters and does not apply to land stations. For example, the encoded group KILN identifies a ship with the call letters KILN. This group is included in every individual ship report.

$YYGGi_w$

This group is encoded the same as the land report.

$99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$

99 indicates that latitude and longitude of the ship's position follow. $\mathbf{L_aL_aL_a}$ is the ship's

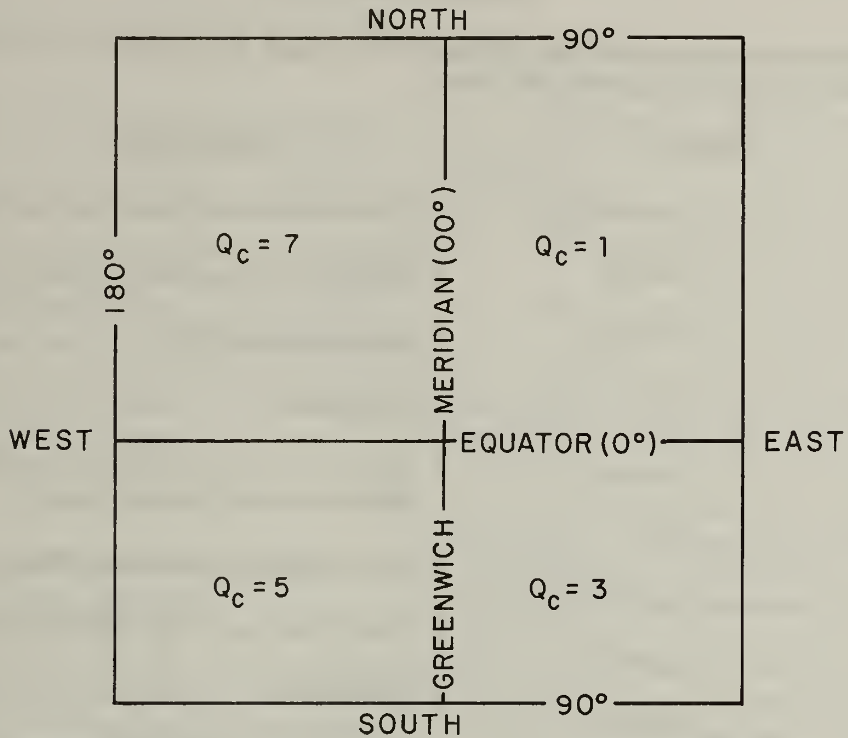


Figure 3-1-1.—Quadrant of the globe.

latitude in tens, units, and tenths of degrees. If the latitude is, for example, 30.6°, then $L_aL_aL_a$ is encoded as 306.

$\mathbf{Q_c}$ is the quadrant of the globe in which the ship is in. Figure 3-1-1 shows the code numbers that should be encoded for Q_c.

$\mathbf{L_oL_oL_oL_o}$ is the longitude where the observation was taken in hundreds, tens, units, and in tenths of degrees. For example, a longitude of 123.2W and latitude of 30.6°N, $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ is encoded as 99306 71232.

$\mathbf{i_Ri_xhVV}$

This group is encoded the same as the land report.

Nddff

This group is encoded the same as the land report.

$\mathbf{1s_nTTT}$

This group is encoded the same as the land report.

$\mathbf{2s_nT_dT_dT_d}$

This group is encoded the same as the land report.

EXERCISE (3-1-6)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

TERM	DEFINITION
1. ________ $M_iM_iM_jM_j$	a. Cloud cover, wind direction, and speed
2. ________ DDDD	b. Indicator for L_a and L_o group
3. ________ $YYGGi_w$	c. Surface temperature
4. ________ 99	d. Longitude
5. ________ $L_aL_aL_a$	e. Base of low cloud, visibility, precipitation data, and weather group
6. ________ Q_c	f. Ship bulletin encoded as BBXX
7. ________ $L_oL_oL_oL_o$	g. Day, time, and wind indicator group
8. ________ i_Ri_xhVV	h. Quadrant
9. ________ Nddff	i. Surface dew point temperature
10. ________ $1s_nTTT$	j. Ship call letters
11. ________ $2s_nT_dT_dT_d$	k. Latitude

4PPPP

This group is encoded the same as the land report.

5appp

This group is encoded the same as the land report.

$7wwW_1W_2$

This group is encoded the same as the land report.

$8N_hC_LC_MC_H$

This group is encoded the same as the land report.

9hh//

This group is encoded the same as the land report.

$222D_sV_s$

222 in this group is the actual indicator identifying the beginning of Section 2 data.

D_sV_s—This is the ship's course and speed made good during the 3 hours preceding the time of observation.

D_s is the symbolic figure for the ship's course. Refer to WMD or FMH-2 Code Table 0700.

V_s is the symbolic figure for the ship's average speed. Refer to WMO or FMH-2 Code Table 4451.

$Os_nT_wT_wT_w$

O is the indicator for the sea surface temperature group.

s_n is the sign of the sea surface temperature. It is the same as the s_n in the air temperature group in Section 1—i.e., positive or negative.

$T_wT_wT_w$ is the sea surface temperature entered to a tenth of a degree Celsius. It is always encoded as a three-digit number. For example, a sea surface temperature of 0.7 °C is encoded as $T_wT_wT_w$ = 007. If for any reason the sea surface temperature is not available, then the entire group is left out of the report.

$2P_wP_wH_wH_w$

$2P_wP_wH_wH_w$ should be used to report wind waves that are visually observed.

P_wP_w is the period of the wave, in whole seconds. Wave period is always reported as a two-digit number. For example, a wave period of 3 seconds is encoded as P_wP_w = 03. If there are no waves because the sea is calm and the P_wP_w is encoded as 00. If the sea is confused and the wave period cannot be determined, then P_wP_w is encoded as 99. If for any reason the wave period cannot be measured, then encode P_wP_w as //.

H_wH_w is the height of the wave reported in units of half-meters. A half-meter is about 1.5 feet. If the sea is calm, then H_wH_w is encoded as 00, and the entire group is encoded as 10000. If the wave height cannot be determined because the sea is confused, then H_wH_w is encoded as //, and the entire group is encoded as 199//. If the wave height cannot be determined or is not available, then the H_wH_w is encoded as //, and the entire group is encoded as 1////. Refer to the code table in section C-10, FMH-2.

$3d_{w1}d_{w1}d_{w2}d_{w2}$ $4P_{w1}P_{w1}H_{w1}H_{w1}$ $5P_{w2}P_{w2}PH_{w2}H_{w2}$

These three groups may be used in a report from a manned ship to report one or two groups of swell waves. These groups should be used only when swell can be distinguished from wind waves.

If only one system of swell is observed:

1. Its direction, period and height should be indicated respectively be $d_{w1}d_{w1}$, $P_{w1}P_{w1}$, $H_{w1}H_{w1}$

2. $d_{w2}d_{w2}$ should be encoded as //

3. $5P_{w2}P_{w2}H_{w2}H_{w2}$ should be omitted.

If a second swell system is observed, its direction, period and height is indicated respectively by $d_{w2}d_{w2}$, $P_{w2}P_{w2}$, $H_{w2}H_{w2}$.

The swell wave period and height are encoded the same as $1P_{wa}P_{wa}H_{wa}H_{wa}$ and $2P_wP_wH_wH_w$. The direction of the swell ($3d_{w1}d_{w1}d_{w2}d_{w2}$) is encoded as true direction, in tens of degrees from which the swell is moving. Examples of groups are: $3d_{w1}d_{w1}d_{w2}d_{w2}$ $4P_{w1}P_{w1}H_{w1}H_{w1}$ $5P_{w2}P_{w2}H_{w2}H_{w2}$. One swell system is observed moving from 170 degrees with period of 6 seconds and an average height of 1.3 feet. Encode as: 317// 40601.

$6I_sE_sE_sR_s$

6 is used for reporting ice accretion on ships and is only included when ice accretion is observed.

I_s is the symbolic form used to identify the source of ice accretion on a ship. Refer to WMO or FMH-2 Code Table 1751.

E_sE_s is the symbolic form for the thickness of ice accretion in centimeters. Example for an ice deposit (accretion) of 4.0cm:E_sE_s is encoded as 04.

R_s is the rate of ice accretion on the ship. Refer to WMO or FMH-2 Code Table 3551.

ICE $c_iS_ib_iD_iz_i$

This group identifies the presence and state of sea ice and ice of land origin. **ICE** indicates that this group is present. When no sea ice or ice

of land origin is observed, this group is omitted from the code.

c_i describes the concentration and arrangement of the sea ice at the time of observation. Refer to WMO or FMH-2 Code Table 3739.

S_i describes the stage of development of the sea ice at the time of observation. Refer to WMO or FMH-2 Code Table 3739.

b_i describes the ice of land origin present at the time of observation. Refer to the code figure from WMO or FMH-2 Code Table 0439.

D_i describes the orientation of the principal edge of the sea ice at the time of observation. Refer to WMO or FMH-2 Code Table 0739.

z_i describes the effect of the sea ice on the ship over the past 3 hours. Refer to WMO or FMH-2 Code Table 5239.

EXERCISE (3-1-7)

Match the correct definition with each term. Enter the number of the definition on the line preceding the term.

TERM	DEFINITION
1. ________4PPPP	a. 3-hour pressure change and tendency
2. ________5appp	b. Ship direction and speed
3. ________$7wwW_1W_2$	c. First swell wave period and height
4. ________$8N_hC_LC_MC_H$	d. Identifies the presence and state of sea ice and ice of land origin
5. ________9hh//	e. Sea level pressure
6. ________$222D_sV_s$	f. Past and present weather
7. ________$Os_nT_wT_wT_w$	g. Base of low cloud
8. ________$2P_wP_wH_wH_w$	h. Second swell wave period and height
9. ________$3d_{w1}d_{w1}d_{w2}d_{w2}$	i. Swell wave direction
10. ________$4P_{w1}P_{w1}H_{w1}H_{w1}$	j. Cloud group
11. ________$5P_{w2}P_{w2}H_{w2}H_{w2}$	k. Ice accretion goup
12. ________$6I_sE_sE_sR_s$	l. Sea weather temperature
13. ________ICE $c_iS_ib_iD_iz_i$	m. Wind waves group

UNIT 3—LESSON 2

PLOTTING SURFACE CHARTS

OVERVIEW

The Identification and proper procedures for plotting synoptic surface charts.

OUTLINE

Land Station

Shipboard

Synoptic

Airways

METAR

PLOTTING SURFACE CHARTS

The purpose of this lesson is to acquaint you with the basics of plotting a surface weather chart.

The "map plotter" is a vanishing breed in the weather office of the eighties. In fact, unless the facsimile circuit goes down, you may never be called upon to plot a chart of any type. However, if the fax does go down, or worse a national emergency restricts the flow of information, you should be prepared to provide your forecaster with the first raw tool; the plotted surface chart.

The maps and charts that you will plot are of prime importance to all concerned because from these maps and charts the forecaster will be able to locate pressure areas, fronts, precipitation areas, ridges, troughs, and numerous other meteorological phenomena of great importance. The maps and charts that you plot are determined by the geographical location of your weather station, its operational requirements, and its area of responsibility.

Learning Objective: Recognize the procedures used to plot weather information ashore and afloat. As well as the positions on weather elements around the station circle.

SURFACE CHARTS

The surface synoptic chart, when plotted and analyzed, is one of the "basic tools" of a forecaster. Accurate plotting of the chart is essential. Three things, in the order of their importance, for which the plotter of the chart must strive are ACCURACY, NEATNESS, and SPEED. Accuracy is essential; the speed and neatness will appear with practice.

Outline charts for selected areas of the world are provided for the plotting of synoptic weather

reports (reports of observations made at weather stations over a large area at a given time). These charts are termed Weather Plotting Charts. The DOD number, title, map projection, scale, and illustration of the various charts are found in the latest edition of the *Defense Mapping Agency* (DMA) catalog of maps, charts, and related products: Part I—Aerospace Products, Volume II; Weather Plotting Charts.

A small station circle is printed on the charts at the geographical location of the major reporting stations. On maps, where the density of reporting stations is a maximum for the scale of the map, station circles are placed in the general location of the station. Stations are identified on the printed map by their assigned station numbers adjacent to the station circle.

Not all reporting stations are shown on the charts. When it is desirable to enter a report from one of these stations, the person plotting the map draws a circle in the location of the station. To facilitate locating stations, all ships and stations should have a master plotting chart which shows all station locations by correctly positioned station circles with both the station index number and name of the station.

This chart can be kept up to date by referring to the *Air Weather Service Products* (AWSP) 105-52, Vol-II, Weather Communications (Weather Station Index) in microfiche format.

The term "weather map" is applied to a weather plotting chart after the synoptic reports have been entered around the station circle. The term is also applied to the chart after the analysis has been made.

There is neither a specified allowance nor an initial distribution of meteorological plotting charts. The responsibility for requisitioning the charts rests with each weather unit. The charts are ordered from DMA in accordance with instructions found in Vol II—Weather Plotting Charts.

Surface charts are normally plotted every 6 hours from the synoptic observations of 0000, 0600, 1200, and 1800 GMT. (For communication purposes the letter "Z" has been assigned as a short designator for GMT.)

The name of the station, date, time, plotter's initials, decoder's initials, and name or initials of the analysts should be entered on EVERY weather map. ALWAYS REMEMBER IN METEOROLOGY THAT ANY MATERIAL WITHOUT A TIME AND DATE IS PRACTICALLY USELESS.

The plotting of simultaneous (synoptic) weather reports enables the forecaster to obtain a more comprehensive "picture" of the existing weather conditions for a given period of time over a large area. When the weather map has been completely plotted, it is analyzed for forecasting purposes. This aids the forecaster in his primary duty, which is the preparation and issuing of weather advices and forecasts.

Plotted Surface Data

The basic data plotted on surface synoptic charts are the land and ship station surface synoptic reports. Our concern here is with the information plotted on the surface chart and its use.

Land station or ship station synoptic observations are encoded in accordance with instructions contained in FMH-2. Synoptic Code (NA 50-1D-2) or *International Meteorological Codes* (Year) (NA 50-1P-11).

LAND STATION CODE PLOTTING.— There are many variations to the synoptic code. The difference in most cases is small, but very important. Be sure to check the WMO Region in which you are stationed or operating for the differences in the code that is employed in your area. Figure 3-2-1 breaks down a sample land station synoptic report.

In general, the data contained in a synoptic report is plotted around the station circle in a counter-clockwise manner, beginning with pressure. This is the easiest method; however, if you can plot in an easier order, use it. The important thing to remember is to plot in the same order all the time to avoid missing elements.

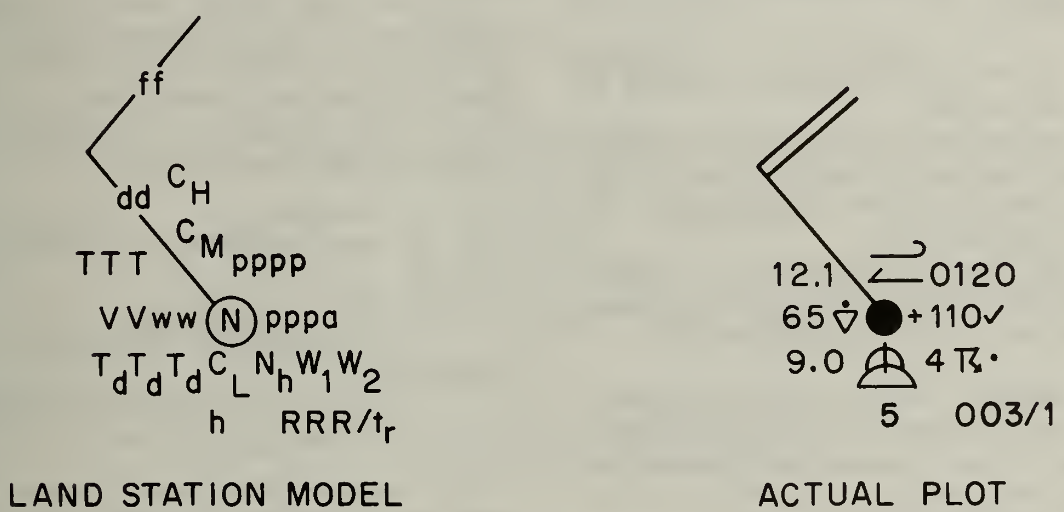
The following procedures are employed for plotting most codes, and have generally been standardized so that the minimum amount of confusion will result:

1. Indicator figures for code groups are not plotted.

2. Most wind directions are reported in tens of degrees. The wind direction, dd, is plotted as the wind direction, in tens of degrees, from which the wind is blowing. When the direction is missing, the ddff portion of the message is not normally plotted.

$i_R i_x hVV$	Nddff	$1s_nTTT$	$2s_nT_dT_dT_d$	$3P_oP_oP_oP_o$	
565	83219	10121	20090		
4PPPP	5appp	$6RRRt_R$	$7wwW_1W_2$	$3N_hC_LC_MC_H$	9hh//
40120	53110	60031	78096	84311	

SYNOPTIC REPORT $\left(\frac{\text{FORMAT}}{\text{EXAMPLE}}\right)$



209.472

Figure 3-2-1.—Land station model.

3. Wind speed is plotted to the *nearest 5 knots* using the symbols explained below. The plotted speed symbols extend *clockwise* from the direction shaft in the Northern Hemisphere, and the reverse in the Southern Hemisphere.

a. A barb (approx. 1/4″ long) and extending from the wind direction shaft represents 10 knots.

b. *One half* barb represents 5 knots. There can be only one of these on a direction shaft.

c. A pennant (approx. 1/4″ long) equals 50 knots. As many of these may be used as is necessary.

d. These three wind speed symbols may be combined to plot any wind speed to the nearest 5 knots. NOTE: When wind speed exceeds 100 knots, 50 is added to the coded direction.

e. There are two exceptions: A calm wind is plotted by simply encircling the station circle ◎, and a wind speed of 1 or 2 knots is indicated by plotting a shaft o—— .

f. When plotting other data around the station circle, keep the plotted data from touching the shaft or barb.

g. When the wind speed is missing, draw the wind shaft and plot an "X" at the end.

4. Wind direction and speed are usually plotted first so that true direction may be shown, and interference with other elements plotted is kept to a minimum.

5. Minus signs are plotted with subzero temperatures.

6. Missing or garbled data:

a. "N" (skycover), a large "X" is plotted through the circle.

b. Wind direction, no wind plotted.

c. **TTT**, "M" when all are missing, "X" for any digit that may be missing or garbled.

d. $\mathbf{T_dT_dT_d}$, Same as TTT.

e. **PPPP**, "M" when missing, "X" for a single missing or garbled character.

f. **5appp**

(1) When the 5 group is missing or garbled, plot an "M".

(2) When the tendency only is missing or garbled, do not plot the sign, but plot an "X" for the symbol immediately to the right of the plotted pressure change.

(3) When the change only is missing or garbled plot the sign, with the change digits represented by "XXX" and the symbol.

g. $\mathbf{6RRRt_R}$, When this group is missing, reference must be made to i_R in the first group of the code. When i_R indicates no precipitation to report, plot slants (/////). Plot an "M" when the group is missing or garbled.

h. $\mathbf{7wwW_1W_2}$, The plotting procedures for present and past weather when data are missing are not as simple as with most groups. When the 7 indicator group is missing, reference must be made to i_x in the first group of the code to determine if there is any significant weather to report. Local plotting procedures may vary, but for the purpose of this lesson it is recommended that slants (//) be plotted when i_x indicates no significant present or past weather. When i_x indicates significant weather to report, and the 7 group is missing or garbled, plot an "M" for present and past weather.

i. **hvv**, The height of the lowest cloud layer (h) will normally be plotted as encoded, with an "M" being plotted when missing or garbled. The visibility (vv) is plotted immediately to the left of the present weather plot or the station circle when no present weather is plotted. Visibility will be plotted as coded with an "M" being plotted when missing.

7. All elements that are plotted are oriented to the adjacent latitude and longitude lines.

8. All legends should be filled out as indicated in the printed portion of the map containing the legend block. If a legend block is missing, information normally entered in the printed legend is entered in the lower left-hand corner of the map. The entries may be rubber stamped or printed block entries. Do not forget your name and rate in the legend.

9. Data plotted around a station circle should cover an area not greater than a dime if possible.

10. The code figures that are coded for temperature (TTT) and dewpoint ($T_dT_dT_d$) are plotted as a three digit number with the tenths figure preceded by a decimal point.

11. When plotting of the map has been completed, check the following items:

a. Neatness

b. Wind direction and speed plotted correctly.

c. Size of station plots.

d. Completeness (all available data plotted).

e. Entry of late and off-time reports.

f. In case of ships, proper location.

12. There are inks of several different colors which can be used when plotting a map to indicate the types of data plotted. Although no standard set of colors exists in the Navy, and the colors used are normally determined locally, the following colors are recommended.

a. Black or blue-black—On-time data or blocks of off-time data (so indicated in the map legend).

b. Red—Gradient winds and off-time data.

c. Green—Data that are entered after the map has been plotted.

13. Be sure to plot the past positions of pressure centers and fronts on the map. The past positions of the pressure centers are indicated by an X circumscribed by a circle with the date and time placed immediately above. The date is indicated by two numbers followed by a colon or solidus (/) indicating the day of the month. The

second two numbers indicate the time of data to the nearest whole hour GMT preceding the time of the appropriate map. Thus, 1200Z on the 20th day of the month is entered as 20:12Z (or 20/12Z).

SHIPBOARD CODE PLOTTING.—At sea there is a lack of the close network of land reports, and a single ship report may be the only one in a vast area. A single ship report, too, may be the only one giving an indication of a developing tropical storm which may be heading for a task force or a heavily populated area. It is especially important that the location of the ship be plotted accurately as well as complete plotting of the data around the station circle.

For ship reports, the use of groups is a little more complicated. A station circle is drawn at the place indicated by the two position groups. The meteorological information is plotted next. This information is found in the remaining groups of the code. Ordinarily, the plot includes the wind group, the weather and visibility group, the pressure group, the cloud group, the pressure tendency group, the sea temperature/dewpoint group, and the wave group, as shown in figure 3-2-2.

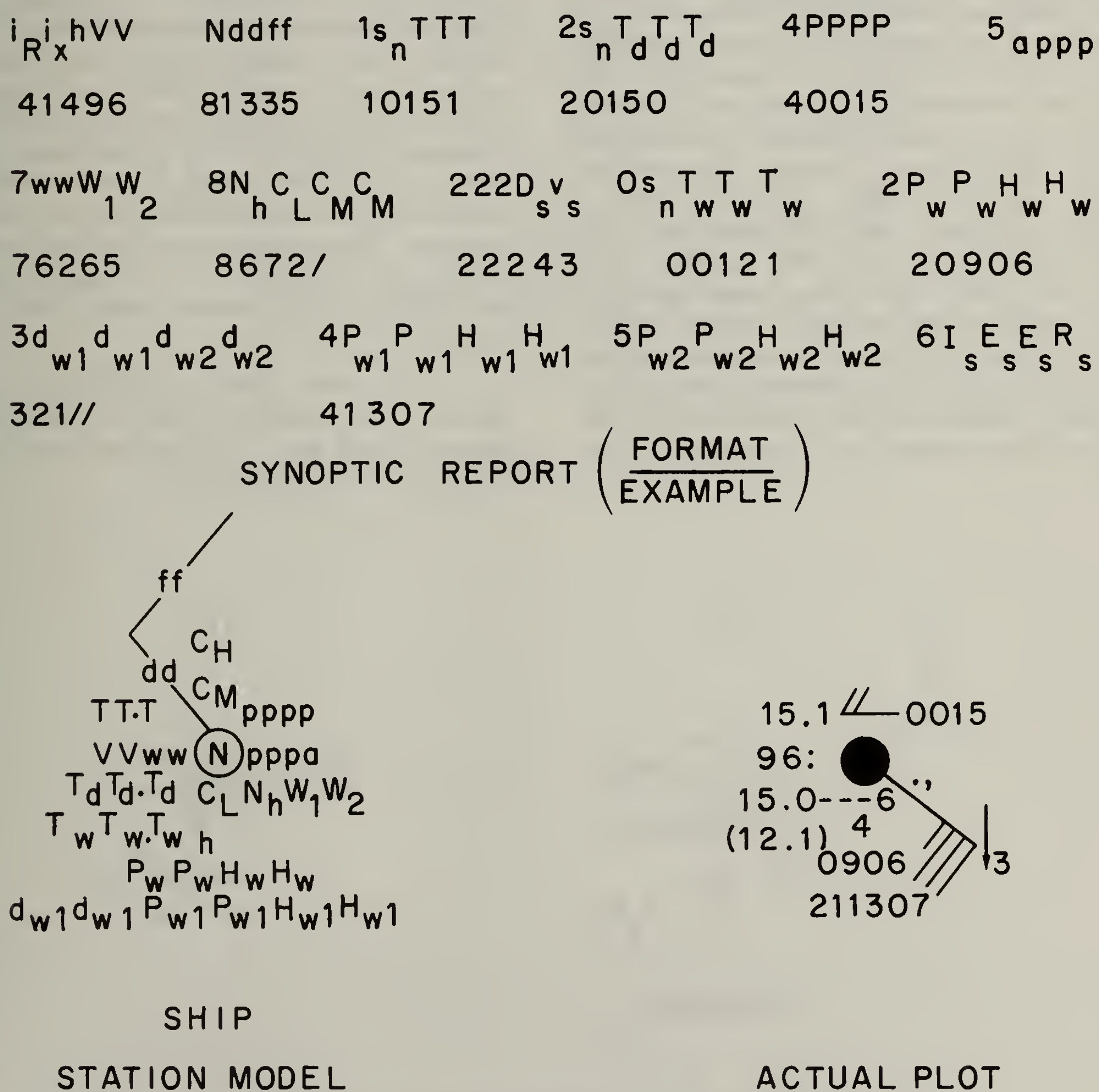


Figure 3-2-2.—Ship station model. 209.473

The first elements to check are the day of the month (YY) and the time (GG), to be sure that the report is consistent with the date-time-group of the chart being plotted.

Next determine the quadrant of the globe to determine if it will fit on the chart you are plotting. If it fits, then locate the latitude and longitude ($L_aL_aL_a$, $L_oL_oL_oL_o$). When this position has been located, draw a 3/16-inch circle at this point, and complete the plot.

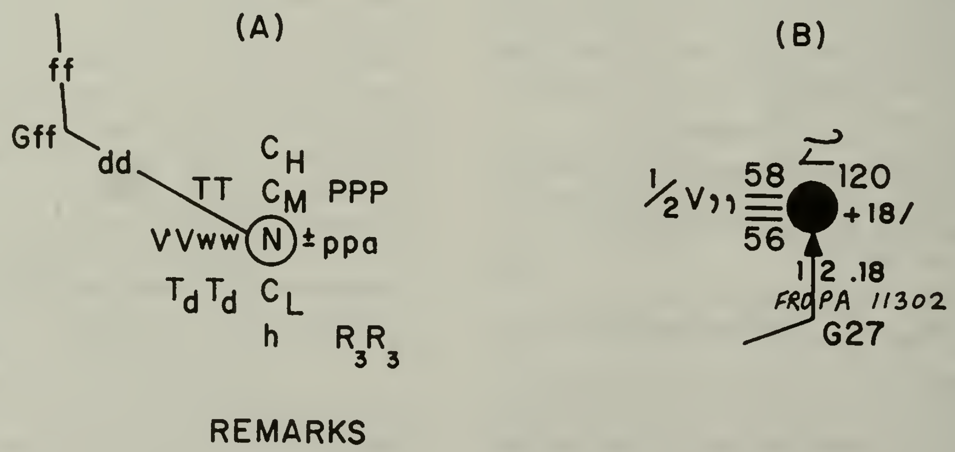
SYNOPTIC (OFF-TIME) PLOTTING.—Since a "synoptic chart" is one showing meteorological conditions observed at various places over a region at or very near the same given Greenwich time, it readily follows that "synoptic data" are those data not normally appearing on a synoptic chart by virtue of being observed at a different time. In other words, synoptic data may be termed "off-time" data. Although there is question as to how much difference may exist between observation time and synoptic chart time, and here again local rules have to apply, synoptic data provide valuable supplements to areas where synoptic reporting stations are sparse or in case of communications failure. Frequently, synoptic reports indicate significant weather developments not apparent at map time.

The criteria for synoptic surface data is surface observations more than 1 hour from the synoptic chart time.

A color code, such as the one given in a previous section of this lesson, should be adopted for plotting such data. These plotted reports must be distinguished from the regular synoptic data because enough changes generally occur during the time intervals to yield an inaccurate or inconsistent analysis if the off-time data were treated as synoptic.

AIRWAYS CODE PLOTTING.—When bad or hazardous weather is approaching the station, it often becomes necessary to supplement the synoptic map with 3-hourly airways maps. These may be either a regular synoptic type chart or a sectional chart. At times it may even be necessary to enter hourly airways maps. These charts give a detailed analysis over a limited area of the relation of pressure systems, fronts, temperature, and humidity to operationally significant weather elements. These maps also enable the forecaster to keep a "weather eye" on the situation and to note any sudden or unusual changes which are occurring.

The Airways Code is probably the most familiar of all weather codes. It is used to plot airways charts and to fill in areas of sparse or little data on synoptic charts.



209.405

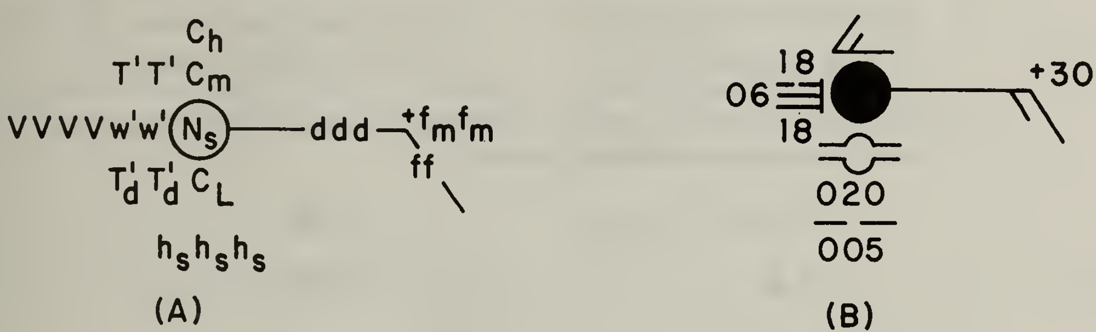
Figure 3-2-3.—Station model for plotting airways reports.

Since the airways maps, when plotted, are subject to careful scrutiny, it is imperative that they be entered both rapidly and accurately. The size, type, and scale of the map, and the amount of data to be plotted are governed by local requirements.

The arrangement of data around the station circle is essentially the same as for the land synoptic code plotting model. Figure 3-2-3 shows a typical station model used for plotting, and a plotted model of the 3-hourly airways code data.

METAR CODE PLOTTING.—The METAR code is used in foreign countries in lieu of aviation hourly weather reports. With the numerous ships and overseas duty stations to which Aerographer's Mates are assigned, it is necessary that a working knowledge of this code be maintained.

The station model format is depicted in figure 3-2-4 along with an actual plot of a METAR report shown.



209.406

Figure 3-2-4.—Station model for plotting METAR reports.

EXERCISE (3-2-1)

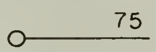
1. When you plot a surface synoptic chart, which of the following is the most important?

   a. Accuracy
   b. Neatness
   c. Speed
   d. Discarding erroneous reports

2. The maps and charts plotted at any given weather station are determined by all but which of the following?

   a. Geographical location
   b. Area of responsibility
   c. Operational requirements
   d. Present weather conditions

3. Assume that the surface wind at a weather station is from 90 degrees at 75 knots. How should this be plotted?

   a. 

   b. 

   c. 

   d. 

4. Weather plotting charts are ordered from

   a. NSA
   b. PSA
   c. DMA
   d. FAA

5. A calm wind is plotted as

   a. circle around station circle
   b. "M" over station circle
   c. "X" over station circle
   d. half-circle around station circle

6. When plotting sea level pressure 4012/(4PPPP), how do you plot the missing character (/)?

   a. XXXX
   b. MMMM
   c. 012X
   d. 012/

7. In which order are the symbols for low, middle, and high clouds arranged around the station circle of the station model for plotting airways reports?

   a. CL—north of centerline; CM—north of centerline above CL; CH—south of centerline
   b. CL—south of centerline; CM—north of centerline; CH—north of centerline above CM
   c. CL—north of centerline; CM—north of centerline above CL; CH—north of centerline above CM
   d. CL—south of centerline; CM—south of centerline below CL; CH—north of centerline

UNIT 3—LESSON 3

PLOTTING OF THE SKEW T, LOG P DIAGRAM

OVERVIEW

Identify the procedure for plotting a complete rawinsonde report on a Skew T, Log P diagram.

OUTLINE

Diagram Familiarization

Radiosonde Code

Plotting Procedures

This lesson will include information concerning the Skew T, Log P diagram and the radiosonde code. The completed Skew T, Log P diagram presents a vertical cross-section of the atmosphere pertaining to pressure, temperature, moisture (dewpoint) and winds aloft. This cross-sectional display assists the forecaster and the observer in determining the freezing level, areas of possible cloud formation, air masses, minimum/maximum temperatures, and stability index for thunderstorms.

You as the observer will receive the coded atmospheric data necessary to complete the Skew T, Log P diagram via the teletype. This data will be received in radiosonde code which you must decode before you "work-up" the diagram. Speed and accuracy are essential in decoding and plotting this information.

Learning Objective: On a Skew T, Log P diagram, plot temperature, dewpoint and pressure-altitude curves, and enter winds of constant-pressure surfaces from a coded rawinsonde report.

NOTE: Before proceeding, open up foldout 3-3-1. Skew T, Log P diagram (found at the end of this lesson), use this example to understand the lesson.

DIAGRAM FAMILIARIZATION

ISOBARS

The horizontal brown lines on a Skew T chart are pressure lines called isobars. These are lines of equal pressure and designate the changes in atmospheric pressure with changes in altitude; the pressure is measured in millibars (mb). These lines are spaced in 10 millibar (mb) increments, ranging from 1050 mb at the bottom of the chart to 100 mb at the top of the chart.

The Isobars are labeled every 50 mb up to and including the 100 mb level in the center and on both sides of the chart. Beneath each labeled millibar level on the left side, the equivalent standard height (altitude) of the level is printed in feet and in meters. You are concerned with plotting in meters only. The meter values are enclosed in the brackets.

ISOTHERMS

The straight brown slanted lines running from the lower left to the upper right of the Skew T chart are temperature lines called isotherms. These lines are lines of equal temperature and are spaced in increments of 1° Celsius (centigrade). They cover a temperature range from +51.5°C to −122.5°C. The lines are labeled every 5°C with the color scheme of the chart alternating from brown to green between every 10°C of the temperature range. This eases point identification while plotting.

Any given temperature and pressure can be identified by one point using the isobars and isotherms. For example, the point plotted in figure 3-3-1 represents a temperature of −5°C at 950 millibars.

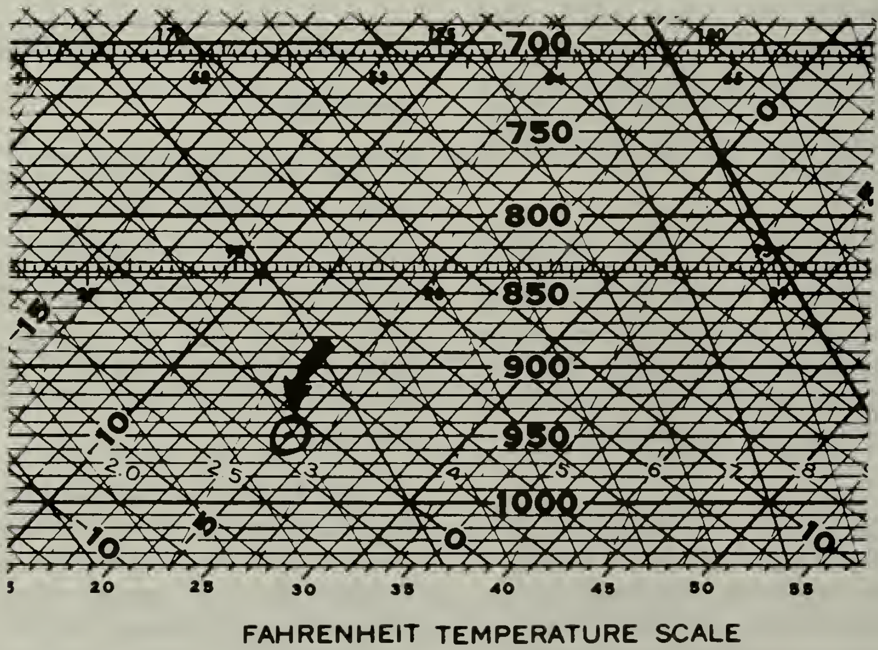
WIND SCALES

The wind scales are located on the right portion of the chart and appear as three black vertical lines segmented by open circles and dots. The open circles on the wind scale represent mandatory pressure levels, which have been selected by the World Meteorological Organization and Air Weather Service, for which wind data must be plotted. The solid circles indicate standard height levels for which wind data are usually reported and plotted. To assist in plotting the winds at standard height levels, a height scale (U.S. STANDARD ATMOSPHERE ALTITUDE) is provided to the right of the wind scales. This scale represents height in feet and meters and provides a reference for plotting wind data on the wind scales at various heights.

RADIOSONDE CODE

A radiosonde is a small battery operated instrument that is attached to a large weather balloon. As the balloon ascends through the atmosphere, the instrument transmits data on temperature, humidity, pressure and winds back to a receiving weather station.

The radiosonde code is a universal code used by military and civilian weather agencies. This



209.480

Figure 3-3-1.—Temperature plot of −5.0°C at 950 mb.

code is used to transmit the atmospheric data obtained from the radiosonde to weather stations around the world. Upon receipt, this data is then decoded and plotted on a Skew T, Log P diagram so that a vertical profile of the atmosphere can be compiled.

The code is received in an alphabetic numerical form. The alphabetical form is used to identify the coded sections, while the numerical form is the actual data that is plotted.

NOTE: To understand the following discussion on the radiosonde code refer to figure 3-3-2. NAS Lakehurst, New Jersey Upper Air Observation Message.

PARTS OF THE CODE

The first step in learning to decode this data will be to understand the alphabetic parts of the code which are: TTAA, TTBB, and PPBB.

TTAA, TTBB, and PPBB

TTAA indicate that the following numerical data is Mandatory Level Data for levels up to and including 100 millibars. These levels will always be plotted.

TTBB indicate that the following numerical data is Significant Level Data and it too will always be plotted.

PPBB indicates that the following numerical data is from the upper wind report.

Date/Time Group

The next portion of the radiosonde code is received in numerical form, and in order to understand it, you must learn a symbolic code which will tell what each group of numbers represents. The first numerical group following TTAA in the message is the date/time group.

TTAA "78001"

The symbolic format of the date/time group (the first group following TTAA) is YYGGI$_d$. Given below is the breakdown and description of this group using the values from the message.

YY	GG	I$_d$
78	00	1

YY indicates the day of the month plus a hidden value indicating the unit of wind speed measurement used. The wind speed in the U.S. is given in knots and the number 50 is used to indicate this. Therefore, the first two numbers of this group are 50 plus the day of the month which in this case is 28. The sum is 78.

GG indicates the time the observation was taken in Greenwich Mean Time (GMT) (Zulu (Z) time). The observations are taken at 0000Z and 1200Z at most stations. Only the first two digits of the time are sent in the message, therefore, the GG numerical equivalent will be 00 or 12. The message has 00 which indicates the observation time as 0000Z.

I$_d$ Indicator that shows the hundreds value of the last mandatory level which includes a

```
TTAA  78001 72409 99030 05050 09015 00211 06060 09005 85490 00646
07016 70010 06900 08527 50560 22764 09047 40718 33372 09045 30916
459// 09071 25090 543// 09096 20255 581// 09099 15475 595// 09615
10745 575// 09100 88225 589// 09098 77132 09628 40508

TTBB  78001 72409 00030 05050 11930 06040 22770 02920 33650 10100
44600 14740 55435 29769 66358 38170

PPBB  78000 72409 90012 09015 09004 09010 90346 09511 09012 08515
90789 09016 09020 09525 91246 09030 09537 9205/ 09050 09061 9305/
09096 08602 940// 09107 950// 09616
```

Figure 3-3-2.—Lakehurst, New Jersey (NEL) Upper Air Observation Message.

wind group. The message has a number 1 which means that 100 millibars is the last mandatory level which includes a wind group.

Station Index Number

The next group in the message is the station index number group. This group tells us where the weather station is located that took the observation. This group follows the date/time group in the message.

TTAA 78001 "72409"

Given below is a breakdown and description of this group, again using the values from the message.

II	**iii**
72	**409**

II—block number. Designates the area of the world where the station is located.

iii—station number. Identifies the originating weather station within the block. 409 is the station number for Lakehurst N.A.S., New Jersey.

Legend Block

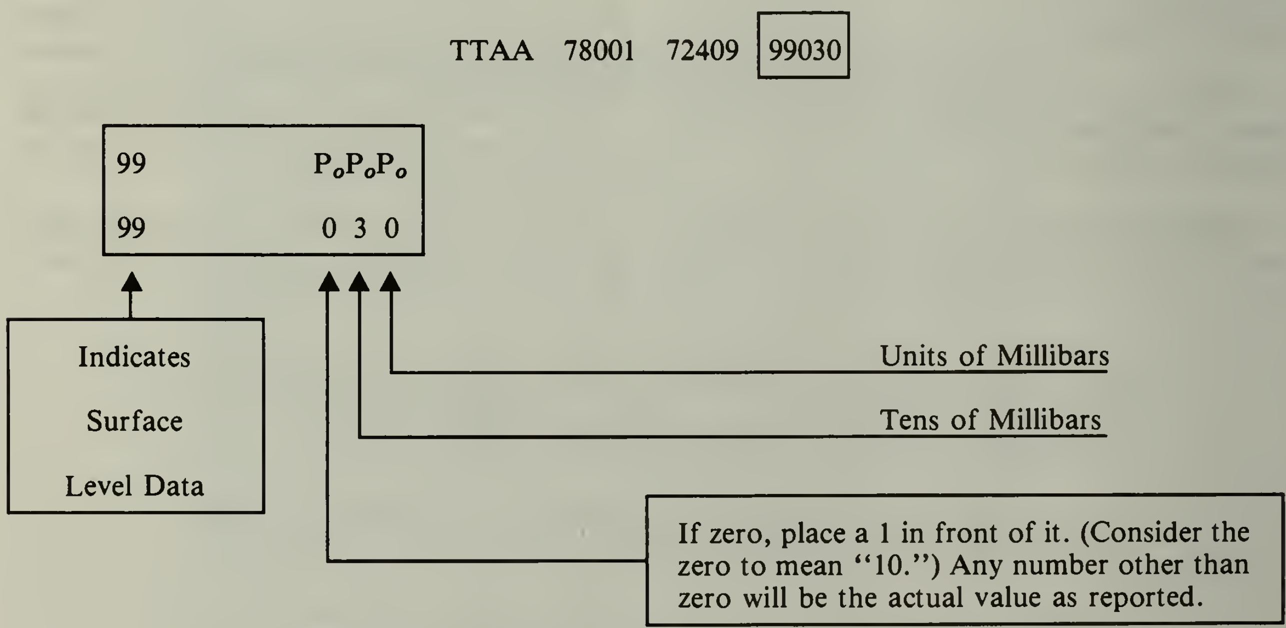
The data for the legend block is self-explanatory. However there is one extra detail, it is helpful to the forecaster if you put the present date after your name (as the plotter) if this date is other than the date of the coded report. Make all entries in capital block letters.

Surface Pressure Group

The next group in the message is the surface pressure group (figure 3-3-3). The symbolic format for the surface pressure group is $99P_oP_oP_o$.

99 is an indicator for the surface level data. It appears in both the symbolic code and in the number group. It is NOT PLOTTED.

$P_oP_oP_o$ gives the surface pressure in whole millibars and is used to locate the surface level on the Skew T, Log P diagram.



This example indicates a surface pressure of 1030 millibars.

Figure 3-3-3.—Surface pressure group.

Surface Temperature and Dewpoint Group

The symbolic format for this group is $T_oT_oT_{ao}D_oD_o$ (figure 3-3-4). An explanation of this group is given below.

$\mathbf{T_oT_o}$ gives the observed air temperature at the surface in whole degrees Celsius. You must, however, be able to determine the temperature to the nearest tenth of a degree and also whether the temperature is positive (+) or negative (−). This is accomplished by the T_{ao} data.

$\mathbf{T_{ao}}$ gives the appropriate tenths value and the plus or minus sign indicator of the surface air temperature. Odd numbered T_{ao} values indicate negative temperatures. Even numbered T_{ao} values indicate positive temperatures.

$\mathbf{D_oD_o}$ gives the depression of the dewpoint at the surface (figure 3-3-5).

Dewpoint is the point to which the air temperature must cool in order for the water vapor in the air to condense into visible moisture. The dewpoint depression tells us how much the present temperature must be cooled in order for visible moisture to form.

Since the depression of the dewpoint is the difference between the temperature and the

TTAA 78001 72409 99030 $\boxed{050}$50

T_o	T_o	T_{ao}
0	5	0

tenths digit/even = positive, odd = negative

units digit

tens digit

(This temperature is read +5.0 degrees Celsius.)

Figure 3-3-4.—Surface temperature group.

TTAA 78001 72409 99030 050$\boxed{50}$

T_o	T_o	T_{ao}	D_o	D_o
0	5	0	5	0

The dewpoint depression is 5.0

Figure 3-3-5.—Surface dew-point depression.

dewpoint, it is reported as a code value to be plotted in conjunction with the temperature.

1. For coded values 00 to 50, consider the decimal point to come between the numbers, i.e., 43 = 4.3°.
2. 51 thru 55 is not transmitted.
3. For coded values 56 to 99, consider the decimal point to come at the end, then subtract 50 from the coded value to obtain the dewpoint depression.

Example: 87 (coded value received)
−50
37° dewpoint depression

PLOTTING PROCEDURES

You have been shown how to decode the surface temperature and dewpoint depression. You will now be shown the procedures for plotting this information on your Skew T, Log P diagram.

TEMPERATURE

The temperature is decoded and plotted to the nearest tenth of a degree. The point at which the decoded temperature intersects the decoded pressure is the plotting point. This point indicates the temperature at that particular pressure level. It is plotted as a dot with a circle around it.

DEWPOINT

The dewpoint is plotted in a similar manner as follows:

1. First subtract the dewpoint depression from the temperature. This gives us the dewpoint temperature.
2. On the same isobar where you plotted the temperature, plot the dewpoint temperature. It also is plotted as a dot with a triangle around it.

The dewpoint temperature is always located to the left of the temperature except when the dewpoint depression is 00. In that case, it is located at the same point as the temperature and both are represented by a dot with a circle and triangle around it.

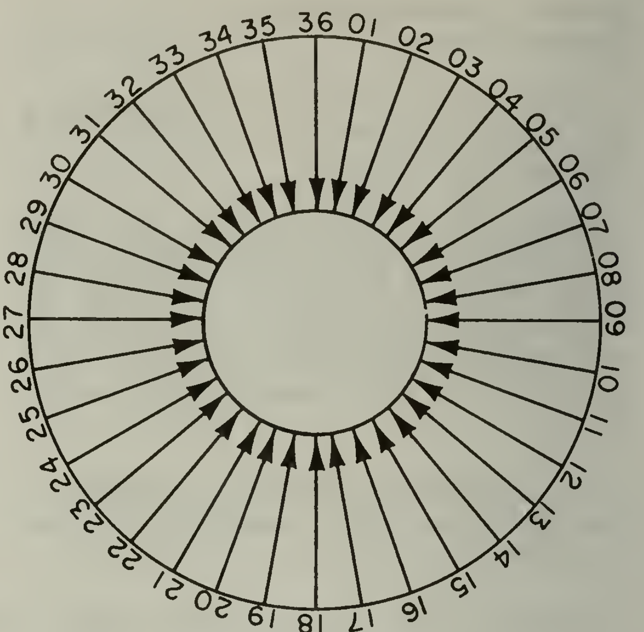


Figure 3-3-6.—Wind rose.

Wind Direction and Speed

The symbolic code for the next numerical group in the message is $d_od_of_of_of_o$. This designates the wind direction and wind speed (force) at the surface level. Prior to decoding this group, you must first understand true directional headings, since wind direction is given in true headings.

WIND ROSE.—Figure 3-3-6 shows a wind rose. The two digit numbers around the outer edge of the circle represent true headings. Starting at the top of the wind rose we find the number 36, which represents 360 degrees or True North. Reading the wind rose in a clockwise direction you find the headings listed in 10 degree increments.

To read the headings place a zero behind each two digit heading. For example: 01 becomes 010 or 10 degrees, 02 becomes 020 or 20 degrees and so on around the wind rose. The headings as applied to wind direction, indicate the true heading or direction from which the wind is blowing.

WIND SCALES.—The Skew T, Log P diagram does not have a wind rose as shown in figure 3-3-6, but has three vertical lines on the right side of the diagram representing north/south

headings. These N/S headings (wind scale lines) are used as the reference for constructing the other 34 headings.

If the wind direction is from 090 degrees, you must draw a line extending outward from the wind scale line forming a 90 degree angle from True North at the desired data level. As shown in example (1) of figure 3-3-7.

All other wind directions are plotted in the same manner. (Refer to the wind rose shown earlier if you need to familiarize yourself with directions.) The other wind direction examples are shown in figure 3-3-7 (2) 170 degrees, (3) 260 degrees and (4) 300 degrees. Only one wind direction is plotted at any one level on the wind scale line.

To assist the forecaster in determining the wind direction when observing the plotted wind shafts, the second digit of the wind direction (*dd*) is plotted at the end of the wind shaft.

WIND DIRECTION.—Now that you understand true wind direction as applied to the Skew T, Log P diagram, let us now decode the surface wind direction and wind speed, $d_od_of_of_of_o$ (figure 3-3-8).

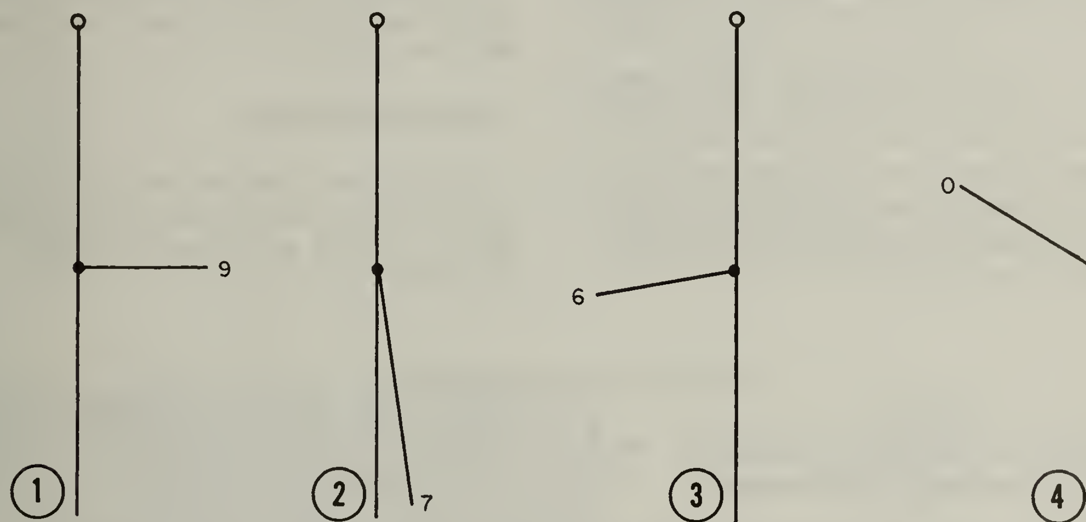


Figure 3-3-7.—Plotting wind direction.

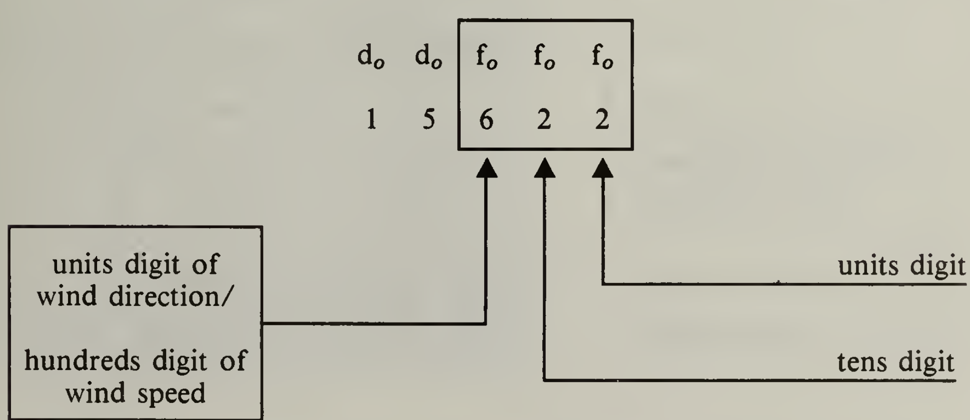


Figure 3-3-8.—Wind direction and speed.

d_od_o represents the true wind direction in tens of degrees (hundreds and tens digits) from which the surface wind is blowing. (Example: 36, 02, 09, 27, etc.)

The wind direction is encoded to the nearest 5 degrees. (e.g., 183 degrees is rounded up to 185 degrees; 162 degrees is rounded down to 160 degrees. This requires the use of f_o of the wind speed section of the five figure wind group $d_od_of_of_of_o$.

Although the wind direction is encoded in hundreds, tens and units of degrees, only the hundreds and tens digits are plotted on the Skew T—the units digit is NOT plotted.

EXAMPLE: If the wind direction is 255 degrees, it will be plotted as 250 degrees.

If the wind direction is 250 degrees, it will be plotted as 250 degrees.

WIND SPEED.—The surface wind speed is designated by the letters $f_of_of_o$ of the symbolic format. It is encoded in hundreds, and tens units of knots (figure 3-3-8).

$f_of_of_o$ is the center digit of the wind group $d_od_of_of_of_o$ and serves two purposes. It gives the units value of the wind direction (either a "0" or a "5") and it also serves as the hundreds digit of the wind speed.

In figure 3-3-8, the wind direction would appear to be from 156 degrees, but the wind direction is only encoded to the nearest 5 degrees. Therefore, rounding off this number to the nearest 5 degrees gives a wind direction of 155 degrees with one left over.

Any remainder left over after the wind direction is rounded off serves as the hundreds value of the wind speed. Therefore, the wind speed is 122 knots.

In summary then, if the center digit of the wind group is not 0 or 5, then the wind speed is 100 knots or more.

Plotting Wind Speed

The symbols that are used for plotting the wind speed on Skew Ts are the universal ones used on surface and constant pressure charts. (See table 3-3-1.)

Table 3-3-1.—Wind speed plotting

Wind speed is plotted on the wind direction shaft as pennants (50 kts), barbs (10 kts) and half barbs (5 kts).

Since the smallest increment that can be plotted is a half barb (5 knots), you must <u>round off the encoded wind speed to the nearest 5 knots</u>.

For example, if the encoded wind speed is reported as:

1 to 2 knots; you would plot:

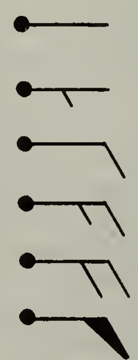
3 to 7 knots

8 to 12 knots

13 to 17 knots

18 to 22 knots

48 to 52 knots



etc.

If the wind is calm, you simply draw a circle around the station circle.

Exp. ⊙

MANDATORY LEVEL DATA

The mandatory level data is received in a series of three 5-digit groups for each level.

Example: 00111 06060 09005

The first group of each series gives the mandatory level in millibars and the height of this level in meters (or tens of meters).

The second and third groups are decoded and plotted in the same manner as the temperature/dewpoint depression, and wind data. The first group is different however, and you must learn the symbolic code and how to decode its numerical equivalent. The symbolic code for the remaining mandatory levels are as follows:

00hhh	TTT_aDD	ddfff
85hhh	"	"
70hhh	"	"
50hhh	"	"
40hhh	"	"
30hhh	"	"
25hhh	"	"
20hhh	"	"
15hhh	"	"
10hhh	"	"

The first two digits (00) of the first group (00hhh) tells us the mandatory level in millibars.

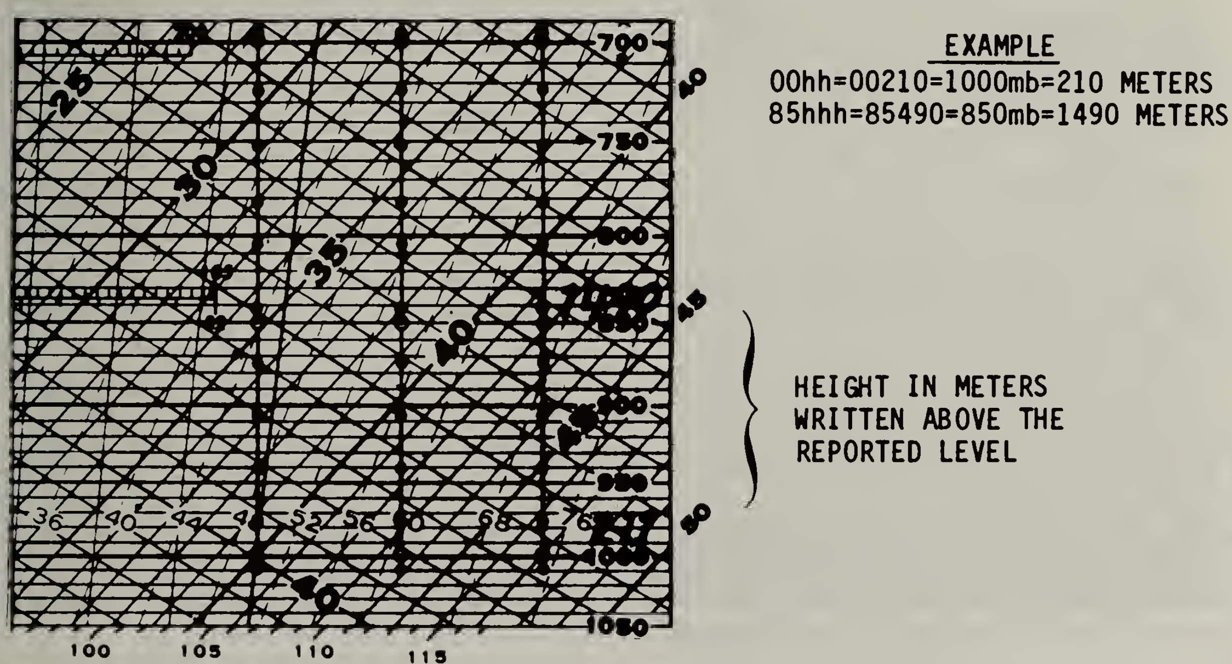
Mandatory Levels

00 = 1000 mb	30 = 300 mb
85 = 850 mb	25 = 250 mb
70 = 700 mb	20 = 200 mb
50 = 500 mb	15 = 150 mb
40 = 400 mb	10 = 100 mb

Height

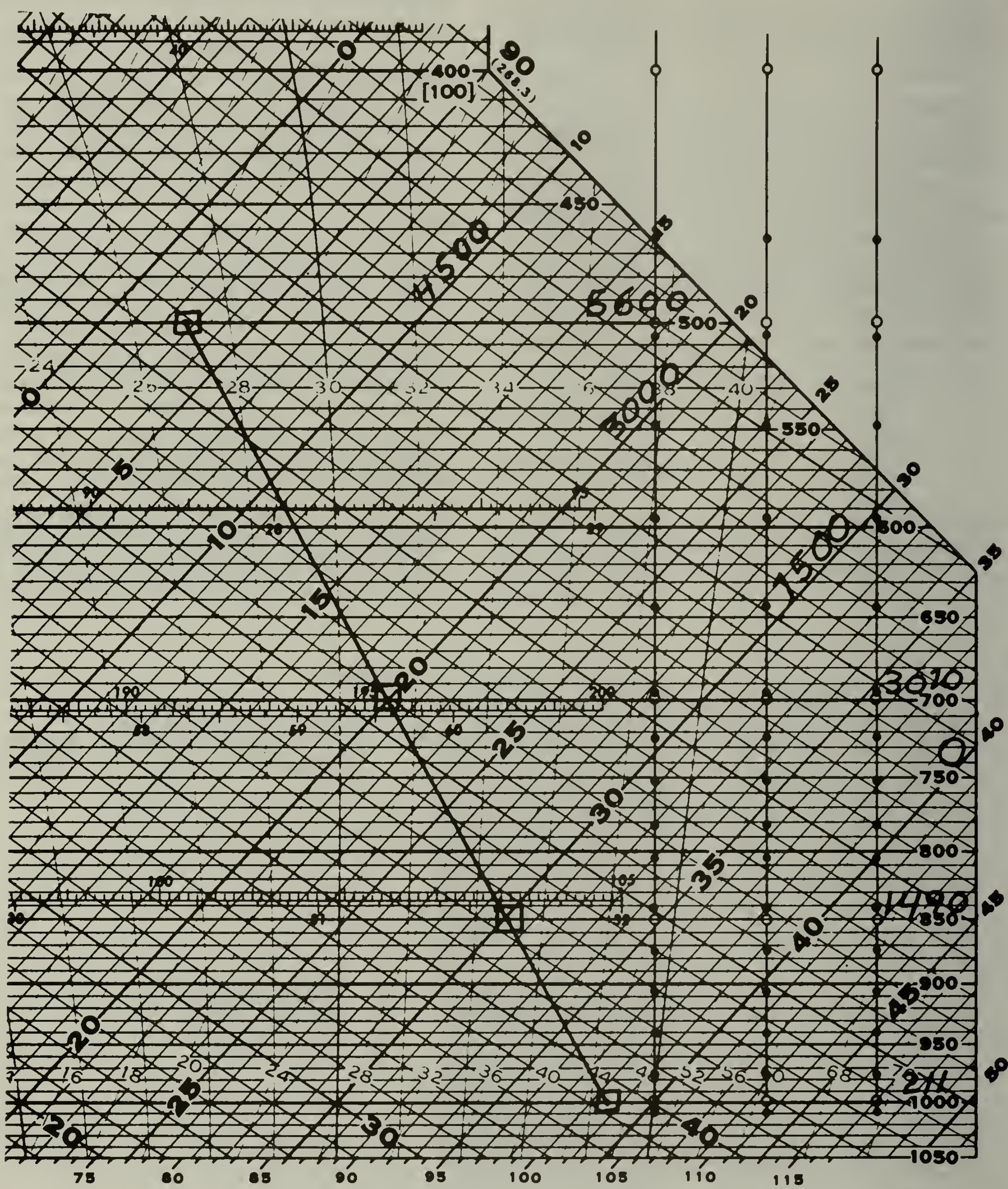
The last three digits (hhh) of this group (00hhh) tell us the height in meters of the mandatory level being reported. Heights are reported in whole meters for the surfaces up to 500 mb (e.g. 150 meters is coded 150; 2,465 meters is coded 465 etc.). For surfaces at 500 mb and higher, heights are reported in tens of meters. Therefore, only the thousands, hundreds and tens digits of height are reported (figure 3-3-9), (e.g. 5,480 meters is coded 584; 12,353 meters is coded 235; 14,628 meters is coded 463, etc.)

There is one exception to the rule. If the 1000 millibar level is below sea level, then the



209.481

Figure 3-3-9.—Height in meters.



209.482

Figure 3-3-10.—Plotting pressure altitude (PA) curve.

1000 millibar level will have a negative height value. This negative height value is encoded by adding 500 to hhh. Therefore, in order to decode it, 500 must be subtracted from hhh and prefixed with a minus sign.

Example:

00hhh = 00545 = 1000 mb at −45 meters

Also, in those cases where the 1000 millibar level is below the surface, the temperature and wind groups are coded with solidi to indicate that they are missing and to maintain continuity in the code.

Example:	00hhh	TTT_aDD	ddfff
	00126	/////	/////

The height in meters of each reported level is written as it is received above the appropriate millibar level on the right side of the diagram.

After placing the height in meters above the designated mandatory level, you would then plot the temperature, dewpoint depression, and the wind data for that level in the same manner as you plotted the surface level data. You would then continue with the next mandatory level group (850 mb) and plot it, continuing until all mandatory levels have been plotted. Non-observed data will appear in the message as solidi (////) which tells you that there is no data available to plot.

PRESSURE ALTITUDE (PA) CURVE

The PA Curve is a height (hhh) versus pressure diagram used by the forecaster to determine the exact height in meters of any temperature of dewpoint (figure 3-3-10).

The first step in plotting the PA Curve is to relabel the isotherms along the right side of the chart as lines of equal height (Isoheights) in the following manner.

Start with the 40° isotherm—label it as 0 meters.

Label the 30° isotherm 1500 meters.

Label the 20° isotherm 3000 meters.

Continue to label every 10 degrees in increments of 1500 meters up to the top of the chart.

The second step is to write the appropriate digit(s) beside the decoded "hhh" values which you have already written above the pressure at each mandatory level. This must be done to complete the height-values in meters. Add the digit(s) as follows:

1000 mb—No addition

850 mb—Prefix a "1".

Example: 1420

700 mb—Prefix a "2" if first digit is "5" or greater.

Example: 2998

Prefix a "3" if first digit is less than "5".

Example: 3102

500, 400, 300 mb—*Suffix* a "0".

Example: 563<u>0</u>

250, 200, 150, 100 mb—Prefix a "1" and suffix a "0".

Example: <u>1</u>042<u>0</u>.

The third step is to plot the height (as determined in step 2) of each mandatory level on the corresponding Isoheight line using a dot with a "box" around it. This is the plotted height symbol.

Since every isoheight (isotherm) line equals 150 meters, go out on the mandatory pressure level line until you reach the point where the isoheight line, with a value closest to the reported height, crosses the mandatory pressure level line. (NOTE: In many cases you will have to interpolate between two isoheight lines to arrive at the reported height.) Place the height symbol at this point.

The fourth and final step is to form the actual PA curve, using a blue pencil and a straight

edge to connect the points. After the points are connected, *the line produced should curve slightly to the right with height.*

TROPOPAUSE DATA

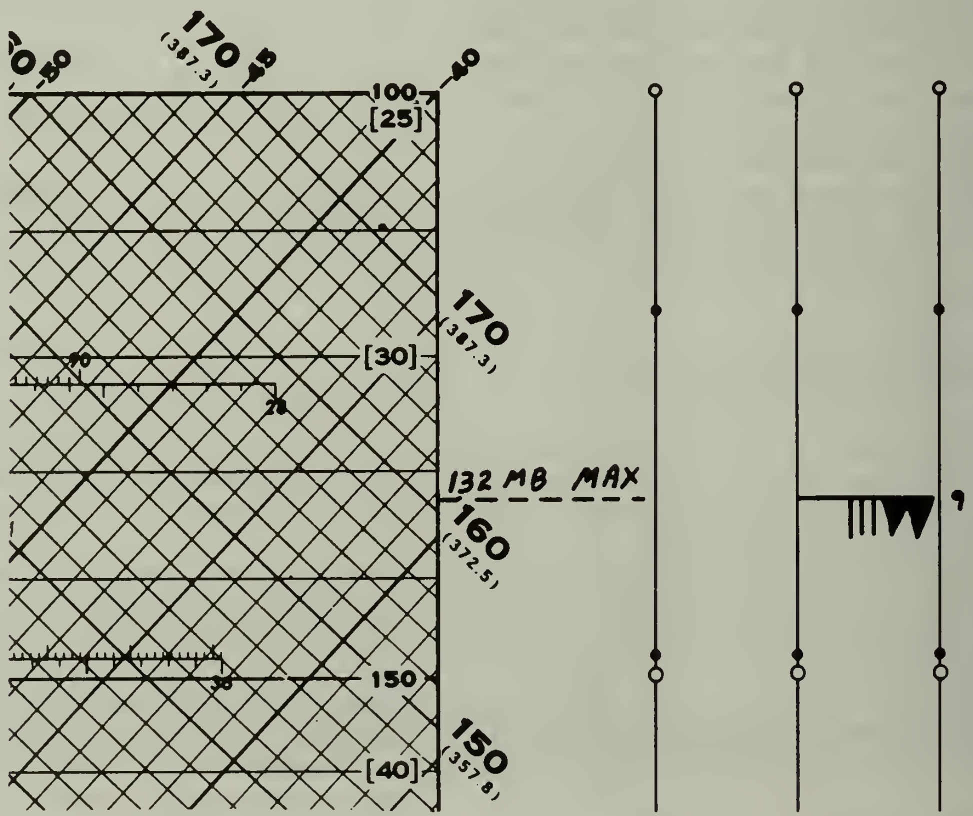
Following the mandatory levels in the message, you will find the tropopause data. This data gives us the point at which the temperature ceases to become colder with altitude and begins to stabilize or become warmer. Like the mandatory levels, it is composed of three 5-digit groups. The only difference is that the first group $88P_tP_tP_t$ is composed of an indicator, "**88**" and the height in millibars "$\mathbf{P_tP_tP_t}$" of the tropopause. The other two groups are the same.

The tropopause data is a mandatory plot and is plotted in the same manner as the surface level. There is only one difference. From the plotted temperature of the tropopause pressure level, a line is extended outward toward the left side of the diagram and the capital letters TROP printed above it.

MAXIMUM WIND DATA

The last data you will receive in Part A is the Maximum Wind Data. See figure 3-3-11 for an

SYMBOLIC FORMAT	$77P_mP_mP_m$	$d_md_mf_mf_mf_m$	$4v_bv_bv_av_a$
MESSAGE VALUES	77132	09628	40508



209.483

Figure 3-3-11.—Plotting maximum wind data.

example of how to plot Maximum Wind Data. The symbolic format for it is:

$\mathbf{77P_mP_mP_m} \quad \mathbf{d_md_mf_mf_mf_m} \quad \mathbf{4v_bv_bv_av_a}$

or

$\mathbf{66P_mP_mP_m} \quad \mathbf{d_md_mf_mf_mf_m} \quad \mathbf{4v_bv_bv_av_a}$

77 or 66—Indicator for maximum wind section:

77—Indicates that the maximum wind was observed at a level below the termination point of the observation.

66—Indicates that the maximum wind occurred at the same level at which the observation terminated.

$\mathbf{P_mP_mP_m}$—Pressure level of the maximum wind.

$\mathbf{d_md_mf_mf_mf_m}$—Wind direction and speed. Plotted on the wind scale in the same manner as other wind observations except that an extended arm with an arrow point is added to the wind direction shaft to indicate the maximum wind.

$\mathbf{4v_bv_bv_av_a}$—Vertical wind shear group. *NOT PLOTTED.*

NOTE: If a 77999 is received, it indicates that no maximum wind data is available.

SIGNIFICANT LEVEL DATA

TTBB 78001 72409 00030 05050 11930
06040 22770 02920 33650 10100 44600
14740 55435 29769 66358 371//

Having completed Part A of the first transmission, you are now ready to begin Part B. This part of the transmission, identified by the heading TTBB, provides a means of reporting significant levels with respect to temperature and/or humidity that are sufficiently important, or unusual, to warrant the attention of a forecaster, and/or are required for precise plotting of the rawinsonde observation. Also included in Part B is information referred to as Additional Data. Additional Data being any information of importance that was not reported for the mandatory and significant levels (e.g. missing data, doubtful data, etc.).

The first section of Part B is similar to the data received in section one, Part A of the message. It is not necessary to plot this section of the message since it is just a repeat of the date, time, station identification, and the surface level data which you have already plotted in Part A.

NOT PLOTTED:

TTBB YYGG/ IIiii $\mathbf{00P_oP_oP_o}$ $\mathbf{T_oT_oT_{ao}D_oD_o}$

TTBB 78001 72409 00030 05050

The remainder of the significant level data is decoded and plotted exactly like the surface level data which you plotted in Part A, except that no wind is encoded, and the message contains some new numbers in the code which indicate the significant level number. The symbolic form of the remainder of the significant level data is shown in table 3-3-2.

TEMPERATURE AND DEWPOINT CURVES

When all temperature and dewpoint plots (both mandatory and significant) have been made, you can construct their curves. Connect all temperature plots with a SOLID BLUE line. Connect all dewpoint plots with a DASHED BLUE line.

ADDITIONAL DATA

Additional data is sometimes sent with the significant level data, and is indicated by the numbers 51515 appearing immediately after the significant level data. The data following this

Table 3-3-2.—Significant level data

11 PPP	TTT_aDD
22 PPP	TTT_aDD
33 PPP	TTT_aDD
.....etc.	

11	PPP	TT_aDD	= Symbolic code
11	930	06040	= As received numerically
Not plotted Indicates significant level number	Indicates pressure level in millibars	Temperature and Dewpoint Depression Plot this as before	

11 = 1st	significant	level	above	surface
22 = 2nd	"	"	"	"
33 = 3rd	"	"	"	"
44 = 4th	"	"	"	"
55 = 5th	"	"	"	"
etc.				

number can vary as to type of data. The symbolic code for additional data is as follows:

(a)	(b)
51515	**$101A_{df}A_{df}$**

(a) The 51515 is an indicator group that tells us that additional data follows. *It is not plotted.*

(b) The $101A_{df}A_{df}$ gives us the code identifier for the type of additional data. The 101 is an *indicator* for $A_{df}A_{df}$.

NOTE: For a complete detail description of the 101 indicator group refer to FMH-4.

UPPER WIND CODE

The last portion of the rawinsonde message is actually a part of the upper wind code (PPBB). Although it is not a part of the radiosonde code, the upper wind code data is included to supplement the wind information already reported in the message. This data is not normally plotted by AGs, but on occasion, it may be used by your forecaster for any number of reasons, including the determination of flight level winds. Let us look now at the explanation of the symbolic format of the upper wind code (PPBB).

PPBB YYGGa_4 IIiii $9t_nu_1u_2u_3$ ddfff ddfff ddfff

PPBB—indicates that the following numerical data is from the upper wind report.

YYGG gives us the day of the month and the time of the observation (GMT). (This YYGG data has already been entered in the legend block.)

a_4 specifies the type of equipment used to measure the winds. (The numeric code for this is not plotted.)

IIiii—the station identifier (previously entered in the legend block).

$9t_nu_1u_2u_3$—this group gives us information on the altitude increments at which the wind data is reported.

9 serves as the indicator for this group.

t_n ten thousands digit of the altitude which applies to the data groups following.

t_n 0. Indicates altitudes between surface—9,000 ft.

t_n 1. Indicates altitudes between 10,000—19,000 ft.

t_n 2. Indicates altitudes between 20,000—29,000 ft.

$u_1u_2u_3$—the thousands digits of the altitudes which apply to the first, second and third ddfff groups which follow.

The three (3) ddfff groups that follow $9t_nu_1u_2u_3$ are the winds for the altitudes reported by $u_1u_2u_3$. These wind data groups are decoded and plotted in the same manner as the wind direction and wind speed in the mandatory level part of the message.

The following fixed regional levels, as determined by the World Meteorological Organization (WMO), will be reported in every PPBB message. *There are black dots on the Skew T diagram wind scales for each of these levels.* The height scale (U.S. Standard Altitudes) on the right of the Skew T will help you find these levels.

Surface	6,000	14,000	35,000
1,000	7,000	16,000	50,000
2,000	8,000	20,000	
3,000	9,000	25,000	
4,000	12,000	30,000	

EXERCISE (3-3-1)

1. **The straight, brown slanted lines are called ____________ and indicate ____________.**

2. **The isotherms are spaced in increments of ____________ ° Celsius and are labeled every ____________ ° Celsius.**

3. **Dewpoint plots are indicated by**

   (a) dot with square around it
   (b) x with circle around it
   (c) dot with triangle around it
   (d) x with triangle around it

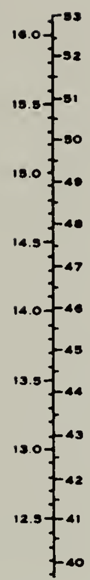
4. **The letters TTAA indicate that the numerical data that follows these letters is for**

   (a) mandatory levels
   (b) significant levels
   (c) maximum wind data
   (d) doubtful data

5. **A dashed blue curve of plotted points on the Skew T is for which element?**

   (a) Temperature
   (b) Pressure height
   (c) Wind
   (d) Dewpoint

EXPLANATION



ISOBARS are straight, horizontal brown lines. The heights of the pressure surfaces in the U.S. Standard atmosphere, below the pressure values on the left, are in parentheses ( ) for values in feet and brackets [ ] for meter values.

ISOTHERMS (°C) are the straight, equidistant brown lines running diagonally upward from left to right.

DRY ADIABATS are the slightly curved brown lines thel intersect the 1000 mb. isobar at intervals of 2°C, and run diagonally upward from right to left. The Dry Adiabats for the overlap portion of the pressure range are labeled with two values. (See below.)

SATURATION ADIABATS are the curved green lines that intersect the 1000 mb. isobar at intervals of 2°C, diverging upward and tending to become parallel to the dry adiabats.

SATURATION MIXING RATIO (in gm. per kg.) is represented by dashed green lines. The values appear between the 1000 and 950 mb. lines.

THICKNESS (in hundreds of geopotential feet and meters) of the layers 1000-700, 1000-500, 700-500, 500-300, 300-200, 200-150, 150-100, 100-70, 70-50, and 50-30 mb. is represented by numbers and a graduation along the middle of each layer. The thicknesses are obtained from the virtual temperature curve by the equal-area method, using any straight line as a dividing line.

HEIGHT of the 1000 mb surface in geopotential feet (or meters) is obtained from the nomogram in the upper lefthand corner by drawing a straight line from the surface temperature (scale at top of diagram) through the mean sea level or station pressure on the pressura scale and reading height on the appropriata height scale.

CONTRAIL-FORMATION CURVES ara thin black lines running diagonally upward from left to right. The solid set of lines is for use between 500 and 100 mb. Tha dashed set is for use between 100 and 40 mb.

U.S. STANDARD ATMOSPHERE SOUNDING is indicated by a thick brown lina.

The saturated adiabats and isopleths of saturation mixing ratio are computed by use of vapor pressure over a plane water surface at all temperatures.

Extension of chart to 25 mb. has been accomplished by overlap with pressura indicated in brackets [100] at 400 mb, and [25] at 100 mb. Dry adiabats for the overlap are labeled in parentheses ( ).

APPROXIMATE VIRTUAL TEMPERATURE may be obtained from the formula $T_v \simeq T + \frac{w}{6}$ where T_v is virtual temperature in °C, T is free air temperature in °C, and w is mixing ratio in grams/kilograms. For purposes of thickness computation, use the mean tem-

RTS

let's briefly
rmat shown

T

27015 00111
70155 07673
25572 08628

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wind speed
ntries report

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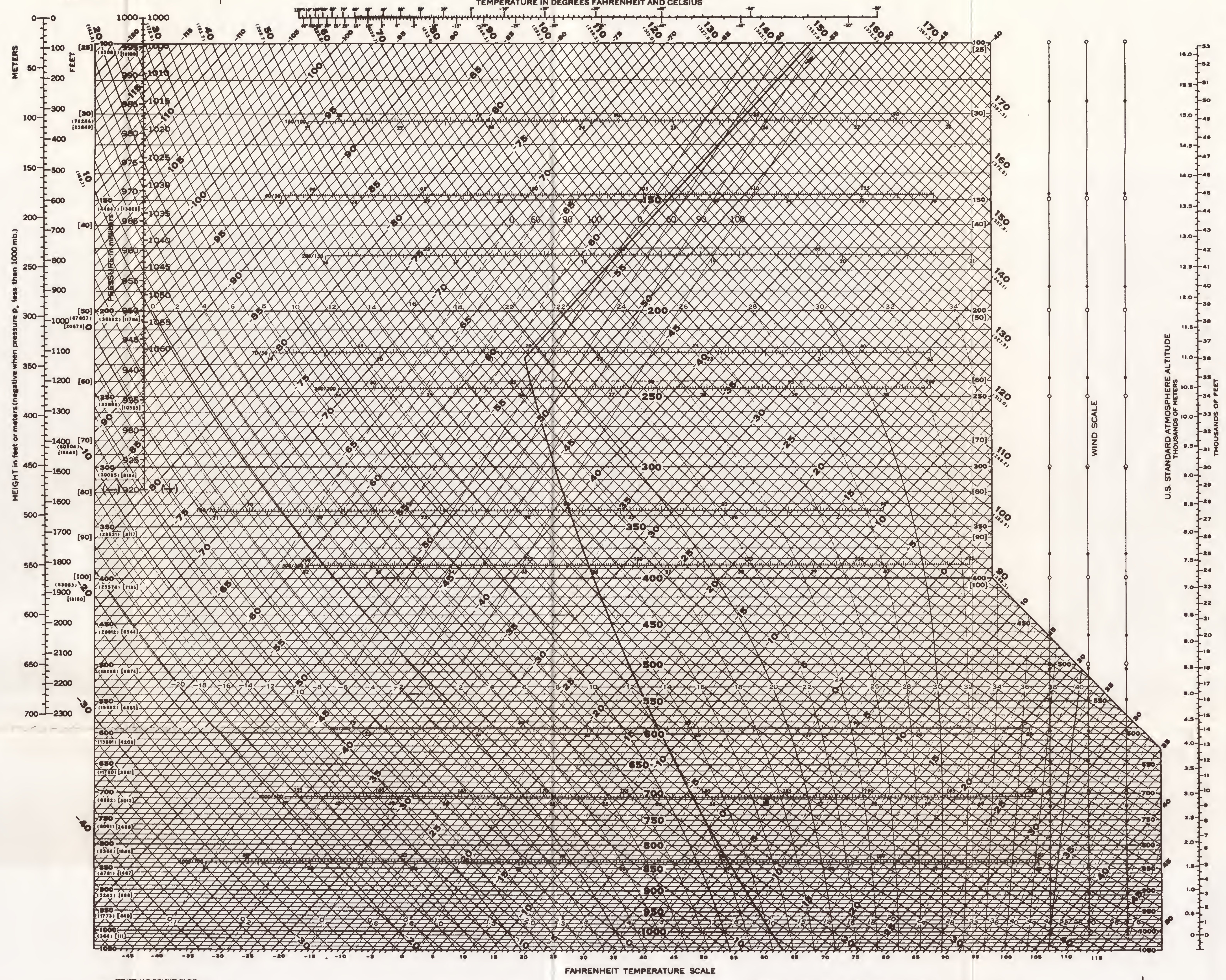
ry level for

Form: DOD-WPC 9-16

DEPARTMENT OF DEFENSE

USAF SKEW T, LOG P DIAGRAM



EXPLANATION

ISOBARS are straight, horizontal brown lines. The heights of the pressure surfaces in the U.S. Standard atmosphere, below the pressure values on the left, are in parentheses ( ) for values in feet and brackets [ ] for meter values.

ISOTHERMS (°C) are the straight, equidistant brown lines running diagonally upward from left to right.

DRY ADIABATS are the slightly curved brown lines that intersect the 1000 mb. isobar at intervals of 2°C, and run diagonally upward from right to left. The Dry Adiabats for the overlap portion of the pressure range are labeled with two values. (See below.)

SATURATION ADIABATS are the curved green lines that intersect the 1000 mb. isobar at intervals of 2°C, diverging upward and tending to become parallel to the dry adiabats.

SATURATION MIXING RATIO (in gm. per kg.) is represented by dashed green lines. The values appear between the 1000 and 950 mb. lines.

THICKNESS (in hundreds of geopotential feet and meters) of the layers 1000-700, 1000-500, 700-500, 500-300, 300-200, 200-150, 150-100, 100-70, 70-50, and 50-30 mb. is represented by numbers and a graduation along the middle of each layer. The thicknesses are obtained from the virtual temperature curve by the equal-area method, nsing any straight line as a dividing line.

HEIGHT of the 1000 mb surface in geopoteetial feet (or meters) is obtained from the nomogram in the npper lefthand corner by drawing a straight line from the surface tamperature (scale at top of diagram) through the mean sea level or station pressure on the pressura scale and reading height on the appropriata height scale.

CONTRAIL-FORMATION CURVES ara thin black lines ranning diagonally upward from left to right. The solid set of lines is for use between 500 and 100 mb. The dashed set is for use between 100 and 40 mb.

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Tha satnrated adiabats and isopleths of satnration mixing ratio ara computad by use of vapor pressura over a plane water surface at all temperatures.

Extension of chart to 25 mb. has been accomplished by overlap with pressura indicated in brackets [100] at 400 mb, and [25] at 100 mb. Dry adiabats for the overlap are labeled in parentheses ( ).

APPROXIMATE VIRTUAL TEMPERATURE may be obtained from the formula $T_v \approx T + \frac{w}{6}$ where T_v is virtual tamperature in °C, T is free air tamperature in °C, and w is mixing ratio in grams/kilograms. For purposes of thickness computation, use the mean tamperatnra of the layer for T and use the mean mixing ratio of the layer for w.

Black dots ● along wind scale lina indicates the levels for which wind data are raported and plotted. The open circles ○ indicata the mandatory prassura levels at which wind data ara also entered.

All heights used in this diagram are in geopotential feet and metars.

SKEW T. LOG P ANALYSIS	
TIME	TIME
AIRMASS ANALYSIS	
TYPE BOUNDARY ________ FT. TYPE BOUNDARY ________ FT. TYPE	________ FT. ________ FT.
FREEZING LEVEL(S)	
INVERSIONS	
FRONTAL	
RADIATION	
SUBSIDENCE	
TROPOPAUSE	
L.C.L.	
C.C.L.	
L.F.C.	
SIGNIFICANT WIND	
MAX.	
MIN.	
LEVELS OF SHEAR	
STABILITY	
INDEX	INDEX
TO	TO
TO	TO
TO	TO
CLOUDS	
TYPE	
AMOUNT	
BASES	
TOPS	
ICING	
TYPE	
SEVERITY	
BOUNDARIES	
CONTRAILS	
PERSISTENCE	
HEIGHT	
TURBULENCE	
DEGREE	
HEIGHT(S)	
MAX WIND GUSTS	
HAIL SIZE	
TEMPERATURES	
MAX.	
MIN.	
CUMULUS CLOUD FORMATION AT TEMP______ TIME______	
DISSIPATION OF LOW LEVEL INVERSION AT ______ TIME______	
REMARKS	
FORECASTER	FORECASTER

NUMBER		STATION
TIME (GCT)	DATE (GCT)	PLOTTER
TIME (GCT)	DATE (GCT)	PLOTTER
TIME (GCT)	DATE (GCT)	PLOTTER

PREPARED AND PUBLISHED BY THE
DEFENSE MAPPING AGENCY AEROSPACE CENTER
ST. LOUIS AIR FORCE STATION, MISSOURI 63118
EDITION 1

STOCK NO. WPCXX0916

Users can assist in the improvement of DOD Weather Plotting Charts by reporting inaccuracies and omission to the appropriate Headquarters, i. e.; Hq Air Weather Service or Director, Naval Oceanography and Meteorology.

Lithographed by DMAAC 6-79

Form: DOD-WPC 9-16
CHART CURRENT AS OF DECEMBER 1965

Foldout 3-3-1.—Skew T, Log P Diagram.

UNIT 3—LESSON 4

PLOTTING CONSTANT PRESSURE CHARTS

OVERVIEW

Plot data for the standard (mandatory) levels on a weather plotting chart.

OUTLINE

RAWINSONDE CODE

Plotting Procedures

RECCO CODE PLOTTING

PLOTTING CONSTANT PRESSURE CHARTS

Constant pressure charts are the basic upper air charts used by the forecaster to analyze the upper atmosphere. They are used in much the same manner as the surface chart is for understanding meteorological processes near the earth's surface. Most constant pressure charts used at weather offices are received via facsimile. However, because of the possibility of a malfunction of the facsimile equipment, you must be able to decode and plot this information from rawinsonde reports for use by the forecaster.

Learning Objective: Given coded rawinsonde reports for selected land stations, plot data for the standard levels on a weather plotting chart.

RAWINSONDE CODE

Since the data for constant pressure charts is obtained from the mandatory level part (TTAA) of the Rawinsonde Code, let's briefly review the Rawinsonde Code format shown below.

RAWINSONDE REPORT

TTAA 78001 72409 99030 05050 27015 00111 06060 28005 85525 12019 27527 70155 07673 09101 50584 09726 09065 40718 25572 08628 30958 38366 27605 etc. — —

TTAA - Indicator for mandatory levels

78001 - YYGGI$_d$

YY - date of observation; 50 is added to all U.S. observations to indicate wind speed reported in knots. Some foreign countries report in meters.

GG - Observation time in whole hours GMT

I$_d$ - Indicates the last mandatory level for which winds are reported.

72409 - IIiii

II - Block number

iii - Station call number

99030 - $99P_oP_oP_o$

99 - Indicates surface data follows

$P_oP_oP_o$ - Surface pressure (millibars)

05050 - $T_oT_oT_{ao}D_oD_o$

$T_oT_oT_{ao}$ - Surface temperature in whole degrees and tenths

D_oD_o - Surface dewpoint depression

27015 - $d_od_of_of_of_o$

d_od_o - Surface wind direction

$f_of_of_o$ - Surface wind speed

PPhhh TTT_aDD ddfff - Symbolic format for mandatory pressure levels.

	PPhhh	TTT_aDD	ddfff	
00 - 1000 MB	00111	06060	28005	(1000 MB Data)
85 - 850 MB	85525	12019	27527	(850 MB Data)
70 - 700 MB	70155	07673	09101	(700 MB Data)
50 - 500 MB	.			
40 - 400 MB	.			
30 - 300 MB		.		
25 - 250 MB		.		
20 - 200 MB		etc.		
15 - 150 MB			.	
10 - 100 MB			.	

PP - Indicates mandatory millibar level (e.g. 85 - indicates 850 MB)

hhh - Height of the level in meters

TT - Temperature in degrees Celsius at the level

T_a - Tenths value of temperature

1. When T_a is *odd* (1, 3, 5, etc.) TT is *negative.*
2. When T_a is *even* (0, 2, 4, 6, etc.) TT is *positive.*

DD - Dewpoint Depression (°C)

1. *A DD of 49 or less* represents the dewpoint depression in degrees and tenths (e.g. 26 = 2.6° depression).
2. *51 through 55* is not used.
3. *When DD is 56 or more,* subtract 50 and the remainder represents the dewpoint depression in whole degrees (e.g. 68 - 18° depression).
4. *A DD of 50* represents a dewpoint depression of 5°.

ddfff - Wind direction and speed

d - hundreds digit of wind direction.

d - tens digit of wind direction.

f - units digit of wind direction rounded to the nearest 5 degrees and also the hundreds digit of the wind speed.

f - tens digit of wind speed.

f - units digit of wind speed.

EXAMPLES:	ddfff	Wind Direction	Wind Speed
	27510	275 degrees	10 knots
	27010	270 degrees	10 knots
	27110	270 degrees	110 knots
	28200	280 degrees	200 knots
	16610	165 degrees	110 knots
	16710	165 degrees	210 knots

PLOTTING PROCEDURES

1. Plot wind direction and speed (ddfff) as follows:

a. Plot winds in the usual manner with a wind shaft and barb(s).

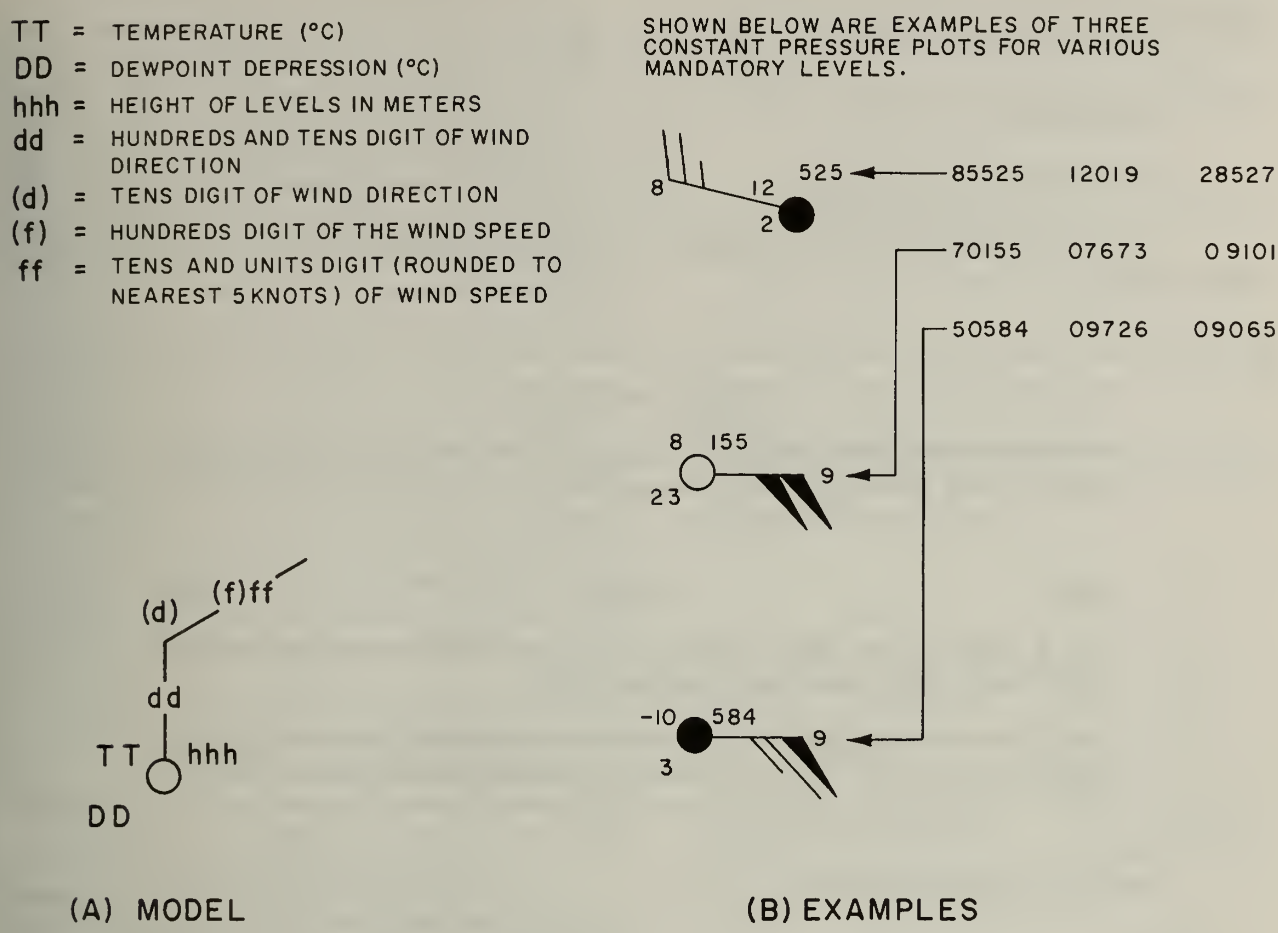
b. Although the wind direction is encoded in hundreds, tens and units of degrees, only the *hundreds* and *tens* are plotted.

c. Plot the *tens* digit of the wind direction at the end of the plotted wind shaft. (Figure 3-4-1.)

d. Plot wind speed to the nearest 5 knots.

e. If the wind is calm, draw a circle around the station circle.

f. If the wind is missing, plot nothing.



209.474

Figure 3-4-1.—Constant pressure plots.

2. Plot the height (hhh) of the mandatory millibar level as reported in 3 digits to the *upper right* of station circle. If the height is missing, plot a dash (-).

3. Round off the temperature to the nearest whole degree and plot it to the *upper left* of the station circle.

a. T_a = 5 or greater, round off to the next higher number; less than 5, round off to lower number.

b. T_a = odd number, Temperature (TT) will be negative, prefix a minus sign.

c. T_a = even number, Temperature (TT) will be positive.

d. TT - 01 thru 09, plot as a single number (i.e. 02 plot 2).

e. If the temperature is missing, plot a dash (-).

4. Plot the dewpoint depression (DD) to the *lower left* of the station circle. Darken or fill in the station circle when the dewpoint depression is 5° or less; leave the station circle open when the depression is more than 5°.

a. Never plot a minus sign.

b. 49 or less, round to the nearest whole degree and plot as one digit. (i.e. 37 = 3.7; plot 4)

c. 56 or more, subtract 50 and plot the remainder in either one or two digits as required (i.e. for a DD of 63, subtract 50 and plot 13).

d. Plot 50 as 5.

e. 51 through 55 are not used.

f. If the dewpoint depression is missing, plot a dash (-).

Each Rawinsonde report has 13 mandatory levels in the TTAA portion of the report. They range from the surface up to the 100 millibar level.

If you are asked to plot a 500 millibar Constant Pressure Chart for instance, you would select only 500 mb data (coded PP value of 50). You would then plot the 500 mb data for each Rawinsonde report on the plotting chart and label the map "500 mb Constant Pressure Level."

EXERCISE (3-4-1)

Using the Rawinsonde message below plot the 850, 700, and 500 mb constant pressure data on the station circle provided.

○	○	○
1.850	**2.700**	**3.500**

TTAA 57121 72409 99008 22256 21012 00108 20848 22017 85489 14637 25529 70123 08259 26043 50571 01176 27601

Note: Most stations that send rawinsonde reports are highlighted on weather maps by having a 12 point compass rose printed around station circle.

RECCO CODE PLOTTING

In addition to the numerous radiosonde reports available, for plotting a constant pressure chart or to enhance facsimile constant pressure charts, there are aerial meteorological reconnaissance observations (RECCO) reports. These reports in coded format (see Appendix IX for additional code format and RECCO observation report form) are from an airborne weather observer.

The report designator always precedes the report and means that the following code data have been obtained from aerial meteorological reconnaissance aircraft in flight. A report that is one of a series from a particular aircraft is generally identified by the name of the flight and number of the report. (EXAMPLE: VULTURE ONE, VULTURE TWO, etc.) An aircraft on a tropical cyclone reconnaissance further identifies the report by adding the name of the storm. (EXAMPLES: VULTURE SUSIE ONE, VULTURE SUSIE TWO, etc.)

The self-identifying groups may be omitted from the report when the data are not available for the report. Groups not identified by group indicators are always included in the report.

Shown below is the symbolic form of the RECCO code with an actual observation. Only the italicized portions of the code are plotted on constant pressure charts. (This, too, is governed by local requirements.) For instance, during tropical storm reconnaissance, it may be desirable to plot the entire report.

RECCO

9xxx9	*GGggi*	$YQL_aL_aL_a$	$L_oL_oL_oV_EV_H$	$\mathit{hhh}d_td_a$
96669	04154	71373	29344	01501

ddfff	WmWMB	$f_eQ_nQ_eQ_sQ_w$	$1K_nN_1N_2N_3$
03035	72902	24443	12389

ChhHH	ChhHH....	$2TTT_dT_d$	3jHHH	(4ddff)
82050	556XX	25560	30017	43335

$6W_sS_sW_cD_w$	$7I_rI_tS_bS_e$	$7h_ih_iH_iH_i$
62596	77174	715XX

$8d_rd_rS_rS_e$	$8w_ea_ec_ei_e$
82851	82433

The 9xxx9 is the first group of the code. This group is not plotted on a constant pressure chart. It is normally coded as 91119 or 96669, because the United States sends height in 100's of feet. If any figures other than these two appear in the code, check the appropriate RECCO code table. The letter i is normally coded as 4 because the United States sends dewpoints; these dewpoints are in degrees Celsius. If a code figure other than 4 appears, check the RECCO code table 2 (found in Appendix IX).

In plotting the RECCO code, the first element to check is the day of the week (Y) and the time, GGgg, to make sure that the report is consistent with the time of the map being plotted. After locating the position of the report on the map from the latitude and longitude groups in the proper octant of the globe, draw a small rectangular box on the map at the proper location. The following elements are normally entered on the constant pressure chart:

hhh True altitude of the aircraft to the nearest hundred feet above mean sea level.

dd Wind direction at altitude given for hhh (36-point compass).

fff Wind speed in knots at the altitude given for hhh.

TT Temperature in whole degrees Celsius at the altitude given by hhh.

T_dT_d Dewpoint in whole degrees Celsius at the altitude given by hhh.

j Index pertaining to HHH, code table 16, RECCO code.

HHH Height of level as designated by j.

The 3jHHH group may not be in the message if the data for the group are in the sounding portion of the message.

(A) and (B) in Figure 3-4-2 shows the RECCO code plotting model for constant pressure charts and actual plotted report.

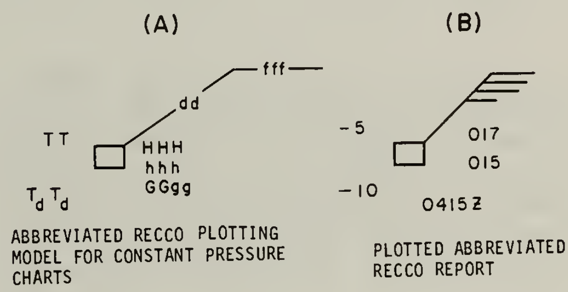


Figure 3-4-2.—RECCO plotting model.

EXERCISE (3-4-2)

1. **On a plotted RECCO report what information appears in the lower left portion of the plot?**

   a. **Temperature (°F)**

   b. **Dewpoint depression (°C)**

   c. **Dewpoint (°C)**

   d. **Temperature (°C)**

UNIT 3—LESSON 5

PLOTTING SEA SURFACE TEMPERATURE AND BATHYTHERMOGRAPH DATA

OVERVIEW

The plotting of sea surface temperature and bathythermograph data.

OUTLINE

PLOTTING SST DATA

PLOTTING BT DATA

THE PLOTTING OF SEA SURFACE TEMPERATURE DATA

To be able to plot Sea Surface Temperature (SST) and Bathythermograph (BT) data, you must understand both the Synoptic Ship and BATHY Codes. SST Data pertains to the temperature of seawater at the surface level and is plotted on surface weather charts at different locations which encompass a broad area of coverage. BT Data deals with a sub-surface temperature profile at a given location for different levels and is plotted on graph paper.

SST charts are used primarily for navigation, naval operations, weather forecasting, and commercial fishing.

Learning objective: State the uses of SST charts; identify the five-digit group of a ship synoptic and bathythermograph report that may be used to plot SST data; recognize the designated calendar days symbols used on a composite SST chart and decode and plot ship synoptic and BATHY SST reports on a surface chart.

When plotting SST data, we normally use synoptic ship and BATHY reports which are routinely available in the weather data communications network. Sea Surface Temperature Reports from Airborne Radiation Thermometers (ARTST) and various ships (CTEM), which are not routinely available will not be discussed in this lesson.

SHIP CODE FORMAT

The following is an example of the symbolic form of the ship synoptic report.

DDDD (ship call sign)

YYGGi$_w$ 99L$_a$L$_a$L$_a$ Q$_c$L$_o$L$_o$L$_o$L$_o$ i$_R$i$_X$hVV

Nddff 1s$_n$TTT 2s$_n$T$_d$T$_d$T$_d$ 4PPPP 5appp

7wwW$_1$W$_2$ 8N$_h$C$_l$C$_m$C$_h$ 9hh// 222D$_s$V$_s$

0s$_n$T$_w$T$_w$T$_w$ 2P$_w$P$_w$H$_w$H$_w$ 3d$_{w1}$d$_{w1}$d$_{w2}$d$_{w2}$

4P$_{w1}$P$_{w1}$H$_{w1}$H$_{w1}$ 5P$_{w2}$P$_{w2}$H$_{w2}$H$_{w2}$ 6I$_s$E$_s$E$_s$R$_s$

ICE C$_i$S$_i$b$_i$D$_i$Z$_i$.

0 Indicator Group

The 0 indicator group is used for plotting the SST data. In the example synoptic report

below, the SST group (00135) has been underlined.

NIJA 12124 99242 71546 42998 03412 10145 20133 40136 53026 78083 85200 22243 <u>00135</u> 20101 334// 40507

The SST is represented by the third through fifth digits ($T_wT_wT_w$) of the 0 indicator group (135) and is encoded in tens, units and tenths of degrees Celsius. The second digit of the 0 indicator group ($0s_nT_wT_wT_w$) indicates whether the seawater temperature is above or below freezing. The code figure 0 indicates a temperature at or above freezing (zero degrees) whereas the code figure 1 would indicate a temperature below zero degrees. The SST is plotted on a surface chart as it appears in the report by plotting a decimal point between the fourth and fifth digits (e.g., 135 is plotted 13.5).

BATHY CODE FORMAT

Bathythermograph (BT) reports are also used to plot SST data. Below is an example of the symbolic form of a BT report.

$M_iM_iM_jM_j$ (JJXX is encoded for this group to identify the report as a BT report.)

YYMMJ GGgg/$Q_cL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ 88888 $Z_oZ_oT_oT_oT_o$ $ZZT_zT_zT_z$ etc., 00000 RADIO CALL (ship call sign, e.g., NIJA)

In the group GGgg, code symbol/figure

/ = temps °C and depths in meters
9 = temps °F and depths in feet

SST Group

The SST group of a BT report is preceded by the 88888 indicator group. In the following BT report, 00178 (underlined) is the SST group. Z_oZ_o (the first two digits) is always encoded with the numerals 00 to identify it as the surface level. The last three digits 178 are encoded for $T_oT_oT_o$ (the SST in tens, units and tenth of a degree Celsius). The SST ($T_oT_oT_o$) is decoded and plotted as it appears in the message by plotting a decimal point between the fourth and fifth digits of the group (e.g., the group 00178 is plotted 17.8). For temperatures below zero, 500 is added to the $T_oT_oT_o$ group (e.g., 00507 is minus 0.7).

JJXX 19082 1130/ 73216 07448 88888 <u>00178</u> 09170 16163 64161 73152 99901 01158 46154 62130 80108 99902 23090 96077 99904 57060 NXXG

SST CHARTS

In the plotting of SST charts, certain oceanic areas such as shipping lanes accumulate a dense coverage of daily SST reports. In other less-traversed oceanic areas, daily SST reports are sparse. Composite charts are plotted in these oceanic areas of sparse coverage to provide the analyst/forecaster with more information for a better analysis. Composite charts are normally plotted using two to five days of SST data. When desired, composite charts using additional data (up to a ten-day interval) may be plotted.

Data Code

The Composite Chart Data Code (day symbols) is used to plot SST data to depict data for different calendar days. The Composite Chart Data Code below is used to differentiate plotted SST data for successive days. (These symbols designate the location of the report or plot.)

DAY	SYMBOL
1st	—
2nd	△
3rd	∇
4th	+
5th	×
6th	·—
7th	·△
8th	·∇
9th	·+
10th	·×

Using the calendar day symbol, an SST of 16.6 °C for the fourth day of a composite chart would be plotted +16.6, and the SST of 20.0 °C for the eighth day would be plotted as ·∇20.0.

Although we use the Composite Chart Data Code (day symbols) to show daily variations of seawater temperature, some weather offices use color code (SST reports plotted in different colors of ink) to minimize data congestion, aid in scanning large quantities of data, and to screen out gross data errors.

If for any reason the validity of an SST report is in question, a line is drawn under the plotted value (e.g., $+\underline{17.7}$). If an SST report is evidently in error and it is corrected *before* plotting, two lines are drawn under the plotted value (e.g., $\triangle\underline{\underline{22.2}}$).

Up to now our plotting of SST data has dealt mainly with synoptic ship reports. In the event a BT report is used to plot SST data, the SST plot should be circled (e.g., when a BT report indicates an SST of 14.6 °C for the first day of composite chart, −14.6 would be plotted).

PLOTTING BATHYTHERMOGRAPH DATA

Learning Objectives: Define the term Bathythermograph (BT) profile and decode and plot a subsurface temperature profile from a BT report.

The second portion of this lesson covers the procedures used to plot BT profiles. Figure 3-5-1 is an example of a plotted BT profile. Note that a temperature profile has been plotted on a piece of graph paper using temperature in degrees Celsius (bottom of graph) and depth in meters (left side of graph) as the parameters. Therefore, a BT profile is a depiction of accurate temperature versus depth information for a particular water column at a given location.

To plot Bathythermograph profiles, it is necessary that you understand the BT code which is preprinted on Bathythermograph logs OCEANAV Form 3167/1. A foldout of the BT log is found in Appendix X at the back of this book.

BT REPORT

The BT report always begins with prefix group JJXX. This four-letter group tells the person receiving it that it is a BT report. The second group (YYMMJ) of the BT report provides the following information:

YY = day: Enter the day of the month as determined using Greenwich Mean Time (GMT) using numbers 01 through 31.

MM = month: Enter the month of the year using numbers 01 through 12.

J = year: Enter the last digit of the year.

For example, if the BT report is for 20 August 1982, the YYMMJ group would read 20082: 20 = day, 08 = August, 2 = 198$\underline{2}$.

The third group of the BT report (GGgg/) provides the following information:

GG = hour: The GMT hour of observation followed by;

gg = minutes: the GMT minutes. The hour and minutes when the bathythermograph entered the water.

The solidi (/) indicates that the temperature is recorded in Celsius and depth in meters (9 is used instead of / if temperature is recorded in Fahrenheit and depth in feet).

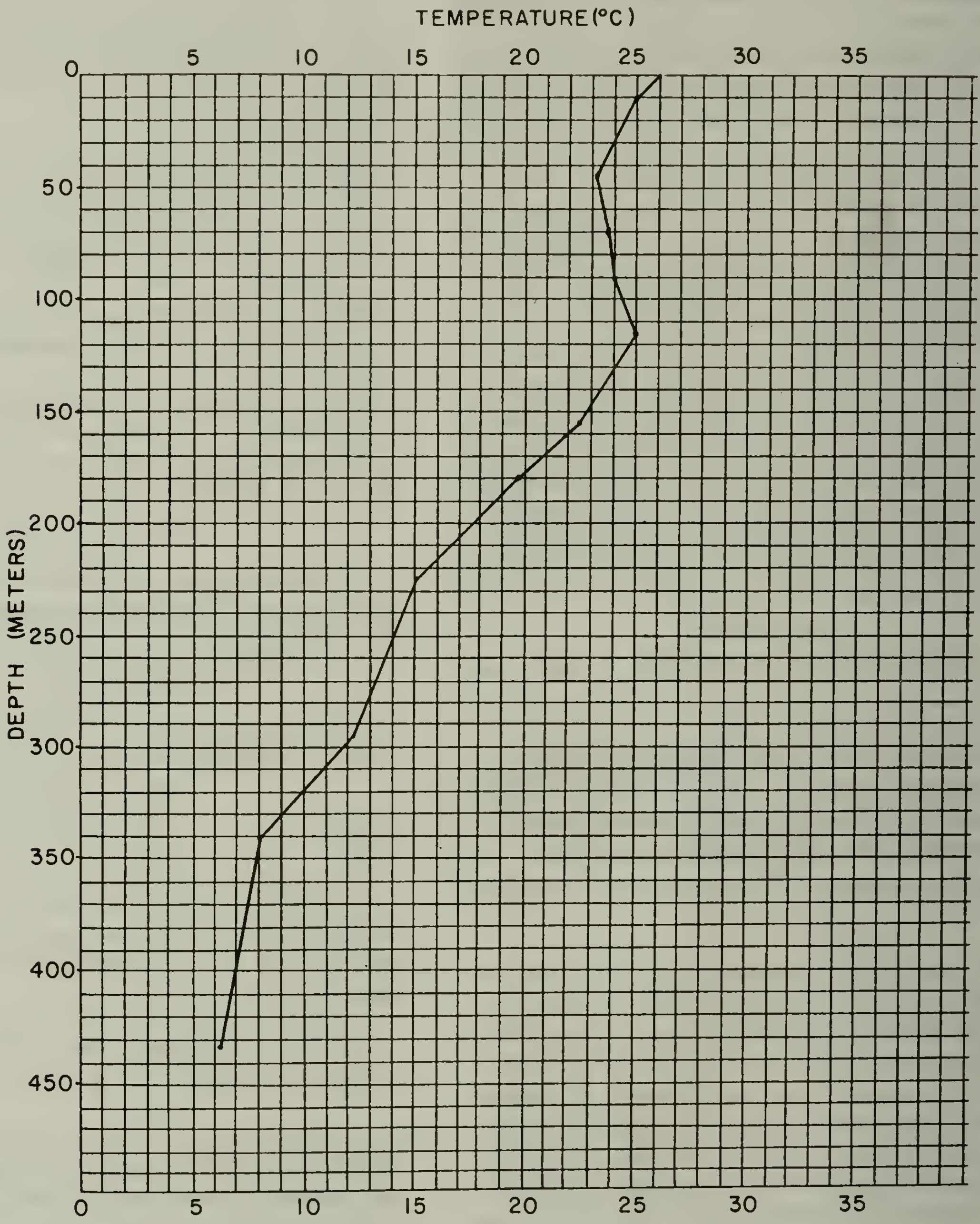
NOTE: Normally, BT observations are recorded in Celsius and meters.

For example, if the time of observation was exactly 1200 GMT and the temperature was recorded in Celsius and depth in meters, the group would read 1200/.

The fourth group of the BT report ($Q_cL_aL_aL_aL_a$) provides the following information:

$\mathbf{Q_c}$ = Quadrant of the globe.

$\mathbf{L_aL_aL_aL_a}$ = Latitude, in degrees (°) and minutes (′).



209.475

Figure 3-5-1.—Example of plotted BT profile.

For example, if the latitude of the BT report is 30°18′ north and between 0° and 180° West longitude (Quadrant 7), the $Q_cL_aL_aL_aL_a$ group would read 73018.

The fifth group of the BT report ($L_oL_oL_oL_oL_o$) provides the following information:

$L_oL_oL_oL_oL_o$ = Longitude, in degrees and minutes.

For example, if the longitude of the BT report is 146°37′ (east or west), the $L_oL_oL_oL_oL_o$ group would read 14637.

The sixth group of the BT report (88888) indicates that temperatures at significant depths follow.

The seventh group of the BT report ($Z_oZ_oT_oT_oT_o$) is the sea surface temperature group. $\mathbf{Z_oZ_o}$ is always encoded *00*; this indicates the surface level. $\mathbf{T_oT_oT_o}$ is the surface water temperature (SST) and is encoded in tens, units, and tenths of degrees Celsius as read from the BT instrument trace. When the temperature trace is unreadable in the first 10 meters, solidi (///) are encoded.

In the eighth group ($ZZT_zT_zT_z$) of the BT report, the **ZZ** indicates subsurface depths to 99 meters (e.g., for a depth of 5 meters, 05 is encoded; for 97 meters, 97 is encoded). $\mathbf{T_zT_zT_z}$ indicates the temperature at depth ZZ in tens, units, and tenths of degrees Celsius. All temperature values of less than 0° Celsius are encoded as $5T_zT_z$. $5T_zT_z$ indicates a negative temperature reading follows (e.g., a temperature value of − 0.5 °C would be encoded as 505).

> For example: Assume that at a depth of 66 meters the temperature is 14.3 °C; the $ZZT_zT_zT_z$ group in this case is encoded as 66143. If at a depth of 94 meters, the temperature was − 1.6 °C, the $ZZT_zT_zT_z$ group would be encoded 94516.

Depth (ZZ) is reported in whole meters using two digits. Depths of less than 100 meters (2 digits) are reported in tens and units digits. For depths of 100 meters or more a special code group (999NN) is used to denote the hundreds value of one or more depth/temperature group(s) following it. The depth portion (ZZ) of the depth/temperature group(s) following a 999NN group is/are recorded in units and tens.

Table 3-5-1 below illustrates the use of the 999NN code group. The 999 portion of the group is an indicator and does not change. NN represents the hundreds figure of depth for the range indicated in the table.

Table 3-5-1.—999NN Code group

DEPTH (meters)	999NN group used
00-99	None
100-199	99901
200-299	99902
300-399	99903
400-499	99904
etc.	etc.

The code group 999NN (underlined) is used once preceding each change in the hundred value of depth regardless of the number of depth/temperature ($ZZT_zT_zT_z$) points reported in the interim. In other words, suppose that points to be reported are as follows:

00 meters/18.7 °C
56 meters/18.7 °C
77 meters/19.3 °C
105 meters/18.8 °C
125 meters/17.0 °C
180 meters/15.0 °C
230 meters/14.0 °C
275 meters/14.0 °C

Based on the information above, the entries are as follows:

00187 56187 77193 <u>99901</u> 05188 25170 80150 <u>99902</u> 30140 75140

Note that the 999NN group was used once to indicate the hundreds value for the three depths reported between 100 and 199 meters and once again preceding depth of 230 and 275 meters.

The ninth group of the BT report (00000), is encoded after the last $ZZT_zT_zT_z$ group and *only* if the last $ZZT_zT_zT_z$ group represents an ocean bottom temperature reading (e.g., an ocean bottom temperature of −3.2°C at 463 meters would be encoded as 99904 63532 00000).

All BT reports terminate with the:

(1) Ship radio call sign (e.g., NAON)
(2) Aircraft squadron designator
(3) The letters ACFT

as appropriate.

EXERCISE (3-5-1)

1. What are four primary uses of SST charts (any order)?

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________

2. Two types of reports that are normally used to plot SST data are

   a. CTEM and ARTST
   b. CTEM and Synoptic Ship
   c. Synoptic Ship and Bathy reports
   d. Bathy reports and ARTST

3. The 0 indicator group in the synoptic ship report provides seawater temperature. How would the groups 01003, 00148, and 00111 be decoded?

   a. __________
   b. __________
   c. __________

4. How would the following synoptic code group be plotted on an SST chart if the report is three days' old? 00133

   a. △13.3
   b. ∇13.3
   c. −01.33
   d. X −01.33

5. In the Bathy report JJXX 06122 1800/ 72733 13720 88888 00094 18100, what is the sea surface temperature?

   a. 10.0 °F
   b. 10.0 °C
   c. 9.4 °F
   d. 9.4 °C

6. What is a BT profile? ____
   ____
   ____

- For items 7 and 8 use the following encoded BT report.

  JJXX 20019 1200/ 73003 07558 88888
  00261 07249 43238 72239 91243 99901
  17250 55225 81199 99902 24150 96122
  99903 39081 99904 24063 NXXG

7. What is the temperature at 72 meters? ____________________

8. What is the temperature at 339 meters? ____________________

UNIT 3—LESSON 6

PLOTTING SATELLITE TRACKS

OVERVIEW

Determine the information necessary to track meteorological satellites over your station.

OUTLINE

APT PREDICT

MESSAGE PLOTTING

PLOTTING SATELLITE TRACKS

In order to obtain data from a satellite, personnel operating the ground equipment require certain satellite prediction data. The APT daily predict message provides the basis for this required information. The satellite track is then plotted, and from this plotted track, the time of acquisition can be computed.

Learning Objective: Using an APT Predict Message, DECODE the reference orbit data and PLOT, within acceptable tolerance, the sub-point track of a weather satellite on an APT Tracking Board.

APT PREDICT MESSAGE

The weather message that contains satellite tracking information is called the APT PREDICT MESSAGE. This message can be produced in two different forms; a weekly message and daily message.

The daily message contains all the information needed to track all meteorological satellites for one particular day. It is distributed via teletype to most Navy weather stations. The weekly message contains information needed to track all meteorological satellites for one particular week. The weekly message is usually delivered via mail. The two forms contain the same information for any given day. The weekly predict is used for stations not having teletype and in the event that it is impossible to disseminate the daily message.

MESSAGE HEADING

As with all weather messages, the APT Predict Message has a heading. The symbolic form of the APT Predict Message heading is shown below:

TBUS 1 KWBC YYGGgg
APT PREDICT
MM YY NAME SS

TB—APT Predict

US—Geographical location

1—satellite has a north to south daytime picture taking orbit.

2—satellite has a south to north picture taking orbit.

3 and 4—Geostationary—earth synchronous satellite.

KWBC—call letters of station originating message. Washington, D.C. in this case.

YYGGgg—date and time message was *transmitted.*

APT PREDICT—identifies message content.

MM—month of the year.

YY—day of the month that data is valid for.

NAME—name of satellite.

SS—series number of spacecraft.

Besides the heading, the APT message contains four parts. Part I contains information on the first orbit of the day (GMT), and orbits four, eight, and twelve for that day. The ascending node longitude and ascending node time for these orbits are given as well as nodal period and nodal increment. Parts II and III contain the satellite's altitude and sub-point track. Part II is for the Northern Hemisphere and Part III is for the Southern Hemisphere. Parts II and III are further divided into day and night portions of the orbit. Finally Part IV is reserved for any remarks pertinent to the operation of the satellite.

PART I

Now let's see just how this information is encoded in the APT Predict Message. Part I will be covered first; the symbolic code for this part is shown below, as well as an actual message.

PART I

$0N_rN_rN_rN_r$ $0Y_rY_rG_rG_r$ $0g_rg_rs_rs_r$ $Q_rL_oL_ol_ol_o$ Tggss $LL_oL_ol_ol_o$

$N_4N_4N_4N_4G_4$ $G_4g_4g_4s_4s_4$ $Q_4L_oL_ol_ol_o$

$N_8N_8N_8N_8G_8$ $G_8g_8g_8s_8s_8$ $Q_8L_oL_ol_ol_o$

$N_{12}N_{12}N_{12}N_{12}G_{12}$ $G_{12}g_{12}g_{12}s_{12}s_{12}$ $Q_{12}L_oL_ol_ol_o$

PART I

01482 00312 05443 23471 T1442 L2867

14862 03332 32000

14900 41221 19468

14941 15109 25064

$0N_rN_rN_rN_r$

01 4 8 2

0—This first zero is an indicator and tells you that the data for the reference orbit (first orbit of the day) follows. $N_rN_rN_rN_r$ is the orbit number for the reference orbit; in this case, 1482.

$0Y_rY_rG_rG_r$ $0g_rg_rs_rs_r$

0 0 3 1 2 **0 5 4 4 3**

These two groups contain the day and *ascending node time* (Zulu) of the reference orbit (first orbit of the day). *The zeros at the beginning of each group are only fillers and have no meaning.* Y_rY_r is the day. $G_rG_rg_rg_r$ is the hours and minutes, and s_rs_r is the seconds. Therefore the day of this example is the 3rd and the time is 12:54:43Z.

$Q_rL_oL_ol_ol_o$

2 3 4 71

The **Q** of this group gives the octant and the $L_oL_ol_ol_o$ gives the longitude of the ascending node. Figure 3-6-1 illustrates the octants of the globe. The tens, units, tenths, and hundredths of degrees of the longitude are given. The hundreds digit is inferred by the octant. The octant in our example is 2. This is north of the Equator between 90°E and the 180° meridian. Then the longitude inferred is 134.71°E.

Tggss

T1442

This group contains the satellite's nodal period in minutes and seconds the T is an indicator; gg

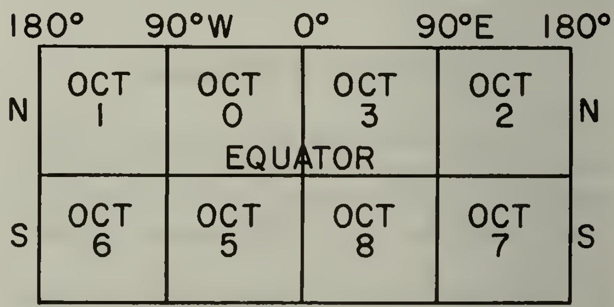


Figure 3-6-1.—Octants of the globe.

is the minutes and ss is the seconds. The hundreds digit of the minutes is not given but the normal period of a satellite is around 110 minutes. Therefore our example shows that the satellite has a period of 114 minutes and 42 seconds which equals 1 hour 54 minutes and, of course, 42 seconds.

$LL_oL_ol_ol_o$

L 2 8 67

The **L** in this group is the signal telling you that this group contains the nodal increment. The increment is given in tens, units, tenths, and hundredths of degrees longitude. In this case the increment is 28.67° of longitude. If the group was encoded L3001, this would give an increment of 30.01° longitude.

NOTE: Longitude and latitude are given to the nearest tenth or hundredth throughout the APT Predict Message.—NOT degrees and minutes of longitude.

$N_4N_4N_4N_4$

1 4 8 6

These N_4's give the orbit number of the (R+4) orbit, i.e., 4 orbits after the reference.

$G_4G_4g_4g_4s_4s_4$

2 0 3 3 3 2

This group contains the ascending node time of R+4 orbit. The ascending node time for R+4 is 20:33:32Z.

NOTE: There are no filler zeros here.

$Q_4L_oL_ol_ol_o$

3 2 0 0 0

This group contains the octant and ascending node longitude for R+4 which is 20.00°E. The data for R+8 (8 orbits after reference) and R+12 are decoded in the same manner as that of R+4. *In some messages there will not be data for R+12.*

Computations

From these orbits, (R, R+4, R+8, and R+12), the ascending node time and the ascending node longitude can be computed for R+1, R+2, R+3, R+5, R+6, R+7, R+9, R+10, and R+11. The following example will illustrate this:

04489 00320 03716 00553 T1611 L2904

44930 44201 12171

44971 22646 22209

45012 01131 30509

ASCENDING NODE LONGITUDE.—To find the ascending node longitude of R+1 (one orbit after reference) perform the following steps:

FIRST: Find the ascending node longitude of R	5.53°W
SECOND: Add *one* nodal increment	29.04
	34.57°W

In the *Western* Hemisphere one nodal increment is always *added* for each successive orbit.

In the *Eastern* Hemisphere one nodal increment is always *subtracted* for each successive orbit.

Just remember:

If EAST longitude-SUBTRACT

If WEST longitude-ADD

Therefore the ascending node longitude of R+2 is found by adding two nodal increments to the ascending node longitude of R and would be 63.61°W. For R+3, once again *add* one nodal increment to R+2 longitude. This would give you 92.65°W as the ascending node longitude for R+3.

Computation Problems.—What do you do when you approach 180°? For example, R+8=172.50°W. Find R+9 when the nodal increment is 28.50°. Remember the satellite always seems to move westward due to the earth's rotation.

R+8 ascending node longitude =	172.50°W
When you add	28.50°
You have	201.00°

Since 201° is over 180° you must determine how far into East longitude the satellite is. To do this you must subtract 180° from 201° and you get 21.00°.

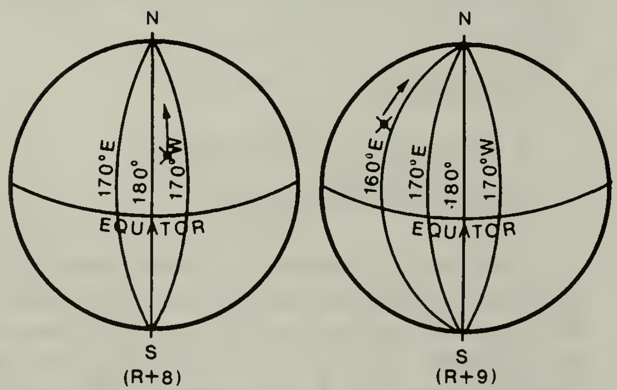
Thus the satellite has moved 21° into the East longitude. To get the ascending node longitude of R+9 you subtract 21.00° from 180.00° since it is in East longitude. Ascending node longitude for R+9 is 159.00°E. (See figure 3-6-2.)

Another problem exists when the satellite approaches 0° longitude.

For example: R+10=5.58°E

Find R+11 when the nodal increment is 28.50°.

Nodal increment	=	28.50°
Ascending Node Longitude	=	− 5.58°E
R+11	=	22.92°W



209.476

Figure 3-6-2.—Changing from West to East.

You need to move westward 28.50°. Subtract the ascending node longitude of 5.58°E from the nodal increment of 28.50°. This equals the ascending node longitude for R+11 of 22.92°W.

Determine R+1 when R is 22.82°E. The nodal increment is 28.14°. The ascending node longitude for R+1 is 05.32°W.

ASCENDING NODE TIME.—Finding the ascending node time is simpler than finding the ascending node longitude. You simply obtain the time of the ascending node for R, R+4, R+8, or R+12 from the message; and if you want to know the time of an orbit other than these, you add one, two, or three nodal periods to the given time. The example below is used to illustrate this:

04489 00320 03716 00553 T1611 L2904

44930 44201 12171

44971 22646 22209

45012 01131 30509

To find the ascending node time of R+1 take:

Ascending Node Time of R	=	20:37:16
ADD one nodal period	=	1:56:11
		22:33:27
		(60 min = 1 hour)

Remember, the nodal period is given in minutes and seconds and the hundreds digit is *omitted*. Therefore, the period of this satellite is 116 min 11 sec, which equals 1 hr 56 min 11 sec.

Similarly, to find the ascending node time of R+2, you must add two nodal periods to R or add one nodal period to R+1, i.e.,

22:33:27
1:56:11

Ascending Node time of R + 2 is 00:29:38Z.

EXERCISE (3-6-1)

Using the message below fill-in the blanks.

APT PREDICT
1222 NOAA 4
PART I
00466 02221 03140 01283 T1500 12875
04700 51141 12783
04741 25141 21715
04782 03141 30215

Orbit Number (1)______________

	Ascending Node Time		**Ascending Node Longitude**
	Hr Min Sec		**Degree Hnd E/W**
Reference Orbit	**(2)___:___:___**	**+ or –**	**(3)____.___°___**
Plus one nodal period	**(4)___:___:___**	**one nodal increment**	**(5)____.___**
Reference Orbit + 1	**(6)__________**		**(7)__________**

PARTS II AND III

You will notice from the symbolic format below, that there are two Part IIs and two Part IIIs.

PART II (NIGHT)

$02Z_{02}Z_{02}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $04Z_{04}Z_{04}Q_{04}$ $L_aL_al_aL_oL_ol_o$

$06Z_{06}Z_{06}Q_{06}$ $L_aL_al_aL_oL_ol_o$ $08Z_{08}Z_{08}Q_{08}$ $L_aL_al_aL_oL_ol_o$

$10Z_{10}Z_{10}Q_{10}$ $L_aL_al_aL_oL_ol_o$ ...to terminator (near North Pole)

PART III (NIGHT)

$02Z_{02}Z_{02}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $04Z_{04}Z_{04}Q_{04}$ $L_aL_al_aL_oL_ol_o$

$06Z_{06}Z_{06}Q_{06}$ $L_aL_al_aL_oL_ol_o$ $08Z_{08}Z_{08}Q_{08}$ $L_aL_al_aL_oL_ol_o$

$10Z_{10}Z_{10}Q_{10}$ $L_aL_al_aL_oL_ol_o$...to terminator (near South Pole)

PART II (DAY)

$28Z_{28}Z_{28}Q_{28}$ $L_aL_al_aL_oL_ol_o$ $30Z_{30}Z_{30}Q_{30}$ $L_aL_al_aL_oL_ol_o$

$32Z_{32}Z_{32}Q_{32}$ $L_aL_al_aL_oL_ol_o$...to last point north of Equator

PART III (NIGHT)

$56Z_{56}Z_{56}Q_{56}$ $L_aL_al_aL_oL_ol_o$ $58Z_{58}Z_{58}Q_{58}$ $L_aL_al_aL_oL_ol_o$

$60Z_{60}Z_{60}Q_{60}$ $L_aL_al_aL_oL_ol_o$...to terminator (near South Pole)

PART II (NIGHT) contains the satellite's altitude and subpoint data at 2-minute intervals for that portion of the orbit which is in darkness north of the Equator.

PART III (NIGHT) contains the satellite's altitude and subpoint data at 2-minute intervals for that portion of the orbit in darkness south of the Equator *prior* to ascending node.

PART II (DAY) contains the satellite's altitude and subpoint data at 2-minute intervals over the sunlit portion of the orbit north of the Equator.

PART III (DAY) contains the satellite's altitude and subpoint data at 2-minute intervals over the sunlit portion of the orbit south of the Equator.

Below is an example of a Part II and III of an APT Predict Message:

NIGHT PART II

02422 062329 04422 124311 06422 186292
08422 247273 10422 309251 12422 371228
14422 432201 16422 492170 18422 552131
20422 610080 22422 666009 24422 718902
26423 760726 28423 783452 30433 775145
32430 740076

NIGHT PART III

02437 061364 04437 123382 06447 185401
08447 247420 10457 308442 12457 369465
14467 429491 16467 489522 18477 548560
20477 606609 22487 661677 24487 713778
26486 756658

DAY PART II

34430 692211 36430 638297 38430 581356
40430 522400 42430 462434 44430 401463
46430 340488 48440 279510 50440 217531
52440 156550 54440 094568 56450 032586

DAY PART III

58455 028603 60455 090621 62465 151639
64465 213658 66465 274678 68475 335700
70475 395724 72485 455752 74485 514786
76485 573828 78485 630884 80496 684963
82496 732085 84496 770286 86496 784578
88487 768734 90487 729540

Sub-Point Information

Now let's see just how the subpoint information is encoded. Both Parts II and III are made up of a series of "paired" groups as in the example below. Notice that the first group has five digits and the second group has six digits.

$\mathbf{02Z_{02}Z_{02}Q_{02}}$	$\mathbf{L_aL_al_aL_oL_ol_o}$
02 4 2 2	**0 62 3 29**

The first two digits in each paired group indicate the minutes after ascending node. In the example, the 02 tells you that the data in these two groups are for the second minute after ascending node.

For example:

If the first two digits of Part II Day are 34, this means that the data contained in the first two groups are for the 34th minute after ascending node.

$\mathbf{Z_{02}Z_{02}}$ This gives the satellite's altitude in tens and hundreds of kilometers. The thousands digit is always a "1" and is not given. The units digit is always a "0" and is not given. Therefore in our example the satellite is at an altitude of 1420 kilometers. An altitude encoded as 18 would mean that the satellite was 1180 kilometers high.

$\mathbf{Q_{02}}$ This gives the octant of the globe that the satellite is in 2 minutes after the ascending node.

$$L_aL_al_aL_oL_ol_o$$

$$0\ 62\ 3\ 29$$

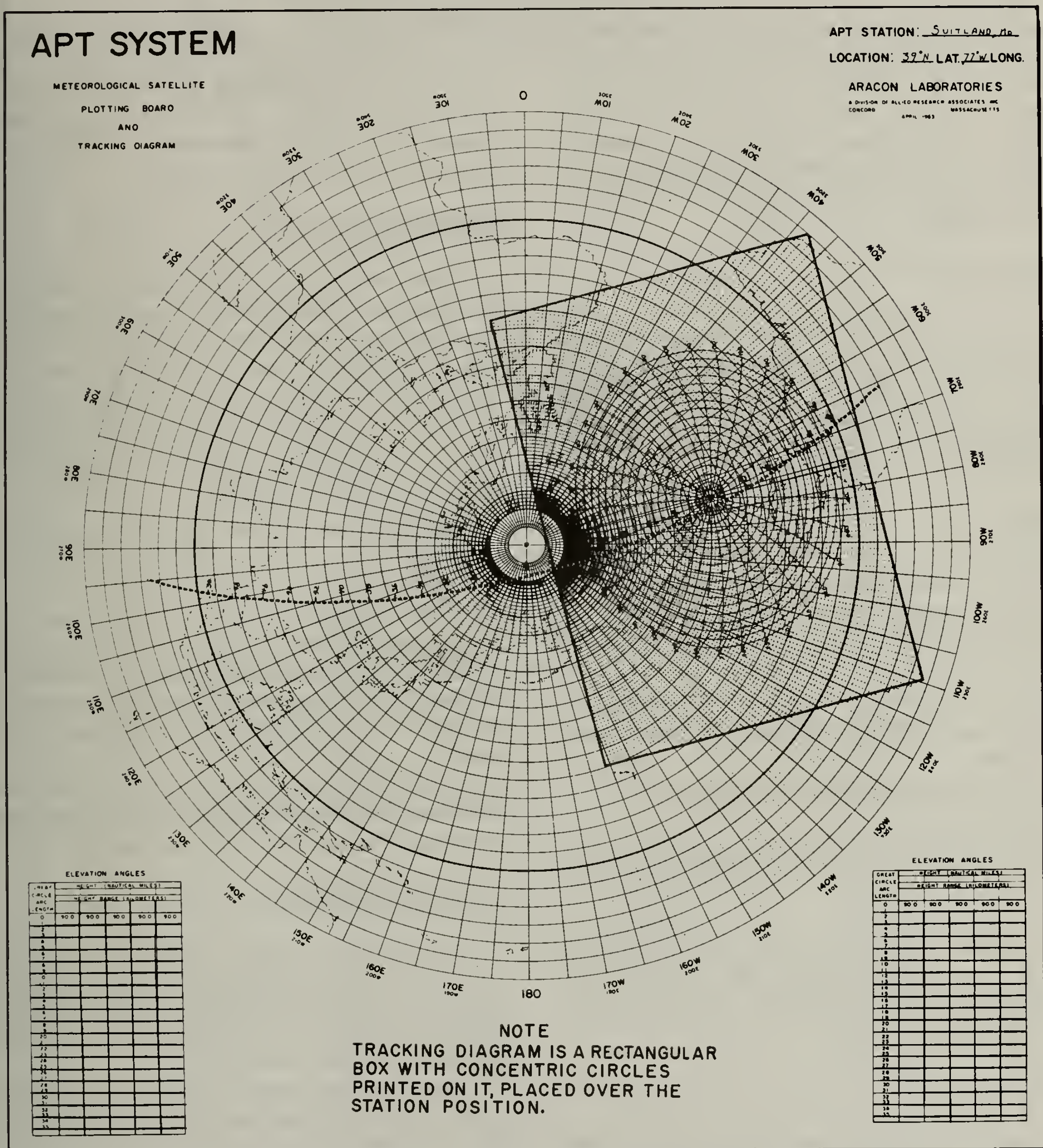
$\mathbf{L_aL_al_a}$ gives the latitude of the satellite's subpoint for the second minute in tens, units, and tenths of a degree. In this case the latitude is 6.2°N.

$\mathbf{L_oL_ol_o}$ gives the longitude of the satellite's subpoint for the second minute in tens, units, and tenths of a degree. The hundreds digit is not necessary since this is obtained from Q_{02}. Therefore, in our example, the longitude is 132.9°E.

You have now decoded the first subpoint of the orbit. All the other subpoints for minutes, (04, 06, 08, etc.) are decoded in the same manner.

PLOTTING

Now you can use this data to plot the actual satellite track. The tools for this task are a grease pencil, masking as well as Scotch tape, and the APT System meteorological satellite plotting board and tracking diagram as shown in figure 3-6-3.



209.105

Figure 3-6-3.—APT Plotting board with tracking diagram.

FIRST STEP

Lift up the clear plastic overlay; take the tracking diagram and center it over your station's location on the plotting board. Be sure that you orient the "0" radial (0° to 180° line) of the diagram towards true North on the plotting board. Tape the diagram to the board using the Scotch tape. Take the masking tape and tape the tracking overlay down to the board so that it will not rotate.

SECOND STEP

First plot the ascending node longitude of R at the Equator on the overlay (remember this is given in Part I). With a grease pencil, make a line on the Equator about 3/4 of an inch at the ascending node longitude. This mark we call Point "0".

THIRD STEP

Now, we will plot the track of the satellite over the Northern Hemisphere given in Part II. The steps for doing this are:

1. Decode the position for the subpoint.
2. Locate this position on the plotting overlay.
3. Make a small dot at this position.
4. Circle the dot.
5. Write the minutes past ascending node beside the circle.

Continue to plot all of the points in Part II Night. The longitude lines near the Pole are quite close so you will have to be careful when plotting these points.

FOURTH STEP

Now plot the daytime Part II data in the same manner. When you have plotted all of the points for Part II Day and Night, *label* portions day and night, and place the satellite name along the track.

Once a given satellite track is plotted, it is usually good as long as the satellite is operational.

Remember the actual satellite orbit always remains the same, only the Earth turns beneath the orbiting satellite.

As stated all you need to display the track of *any* orbit is that orbit's ascending node longitude. You can accomplish this on your plotting board by rotating the tracking overlay until Point "0" is over the ascending node longitude of the orbit you wish to display.

ORBIT TRACKS

From the previous information you have learned how to determine the ascending node time and position of the day's orbits. The next step is to see how many of these orbits pass into your area of reception. By rotating the already plotted track to each of the ascending node longitudes, you can display the track of each orbit of the day. However, you do not need *every* orbit, only those within your area.

To find out if any given orbit can be received:

1. Determine the orbit's ascending node longitude.
2. Rotate the plotting overlay so that minute 0 (the line drawn at the Equator on the overlay) is over the ascending node longitude of the orbit.
3. Check to see if at least four plotted points (8 minutes) of the orbit fall within the concentric circles printed on the tracking diagram.

Tracking Information

In order to "track" a satellite you must know where to point the antenna. This is accomplished by knowing the satellite's azimuth (direction from your station) and elevation (angle above the horizon).

Below are the steps you must complete in order to obtain the azimuth and elevation angles for any orbit.

1. From the plotting overlay determine all *plotted* minutes that fall within the outermost circle on the tracking diagram and write the minutes down in the extreme left column (time AAN) of the APT tracking Worksheet shown in figure 3-6-4. Also include the minute that is

APT TRACKING WORKSHEET

STATION ________ SPACECRAFT ____________

EQUATOR CROSSING

TIME: ________ Z

TIME AAN	TIME (Z)	AZIMUTH	ELEV.	ARC LENGTH	ALTITUDE
23					
24					
26					
28					
30					
32					
34					
36					
38					
40					
42					
43					
44					
46					
48					
50					
52					
54					
56					
58					

NOTE

THE MINUTES AAN ARE JUST AN EXAMPLE. THE ACTUAL AAN TIME WOULD BE BASED ON THE TRACK.

209.477

Figure 3-6-4.—APT tracking worksheet.

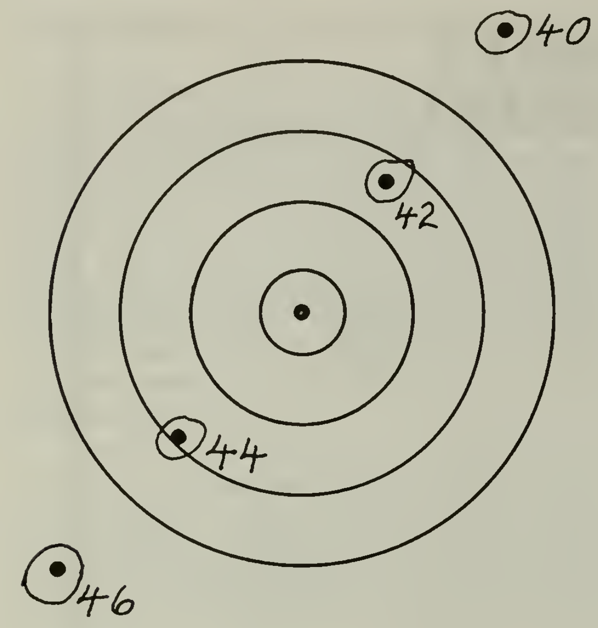


Figure 3-6-5.—Example of orbit track overhead station.

closest to the station if it is not one of the minutes already listed. In figure 3-6-5 Minute 43 would be included because this is the minute when the satellite is closest to the station. Finally include the minute when the satellite first crosses into, and leaves the tracing diagram. In some cases this will be a minute between the plotted minutes.

2. To fill out the time (Z) column you must add the minutes you listed in the time (AAN) to the ascending node time of R + 1.

3. To determine azimuth for each minute, use the radial lines on the tracking diagram.

4. The next column entitled Arc Length is the number of the concentric circle that the minute is plotted on. Number the concentric circles beginning with 2 (the innermost) and ending with 36 (the outermost). You must interpolate to the nearest whole number.

5. The next column, altitude, is obtained from the APT message. For each of the receivable minutes, determine the altitude from Part II of the APT predict.

6. Now using the arc length, the altitude, and tables found in the APT User's Guide, determine the elevation angle for each minute.

You now have all of the information needed to track a meteorological satellite with any type of ground equipment.

EXERCISE (3-6-2)

Given the following coded information for the DAY PART II section of an APT Predict Message

34430 692211

1. **What minute after ascending node is indicated?**
2. **What is the altitude of the satellite?**
3. **What is the latitude and longitude of the satellite subpoint indicated?**

UNIT 3—LESSON 7

PLOTTING RADIOLOGICAL FALLOUT PREDICTIONS

<u>OVERVIEW</u>

Identify information necessary to determine areas which are potentially hazardous because of fallout following a nuclear explosion.

<u>OUTLINE</u>

NAVY FALLOUT MESSAGES

PRE-BURST PREDICTION MESSAGE

CONSTRUCTION OF A RADFO DIAGRAM

FALLOUT WARNING

PLOTTING RADIOLOGICAL FALLOUT PREDICTIONS

In the event of a nuclear detonation, radiological fallout (RADFO) may be of great significance to the conduct of naval operations. This lesson provides you with the information necessary to determine areas which are potentially hazardous because of fallout following a nuclear explosion.

In predicting the fallout area, you must know the location of the burst, the yield of the weapon, and the atmospheric wind structure. Except for experimental tests, only the wind structure can be available before the detonation. The procedures explained in this lesson provide the guidance necessary to prepare a generalized radiological fallout plot which will be available for tactical purposes in reacting to low-yield and high-yield nuclear explosions.

Learning Objective: Identify and interpret RADFO Messages and plot radiological fallout diagrams.

NAVY FALLOUT MESSAGES

There are two formats for Navy fallout messages. The first, called a "*Pre-burst Prediction Message*" is designed to give the forecaster an ideal as to where radiological fallout would go *if* a nuclear weapon is detonated at a given position. The information can be provided for every five degrees of latitude and longitude and includes data for both low-yield and high-yield weapons.

The second type of fallout message called a "*Fallout Warning*" is for when a nuclear weapon has been detonated. In this case, the exact position of the detonation is known as well as the yield (size) of the weapon. This type of message is an actual warning of nuclear fallout from a weapon that has exploded, whereas the pre-burst prediction message is for determining the fallout area just in case a weapon is detonated in the area.

PRE-BURST PREDICTION MESSAGE

The heading for the pre-burst prediction message is PRE-BURST PREDICTION, 24 HR

FCST FROM 12Z 05 OCT 82. It begins with the words PRE-BURST PREDICTION which tells you the type of radiological fallout message. Next the heading gives the time span that the forecast is valid for. Finally, the beginning time of the forecast period is given.

$QL_aL_aL_oL_o$ Tddss DDDDD Tddss DDDDD is the symbolic format of the pre-burst prediction message. Since you will be decoding and plotting pre-burst prediction messages, it is necessary that you learn the symbolic format and the meaning of all the elements contained in it.

Q	Octant of the Globe	Northern Hemisphere 0 ....0° to 90°W 1 ....90°W to 180° 2 ......180° to 90°E 3 ....90°E to 0° Southern Hemisphere 5 ....0° to 90°W 6 ....90°W to 180° 7 ......180° to 90°E 8 ....90°E to 0°
L_aL_a	Latitude in whole degrees for the point for which fallout forecast is made.	
L_oL_o	Longitude in whole degrees for the point for which fallout forecast is made.	The hundreds digit is omitted for longitudes 100 to 180 degrees.
T	Designation of applicable template for a low-yield or high-yield weapon.	# Template 1 ALFA 2 BRAVO 3 CHARLIE 4 DELTA 5 ECHO 6 FOXTROT
dd	Direction of effective fallout wind measured in tens of degrees clockwise from true north.	The template delineates the shape of the fallout area.
ss	The effective fallout wind speed in knots.	The effective fallout wind (ddss) is an average of the winds that will affect the fallout particles above the forecast point.

DDDDD	The distance in nautical miles from the forecast point (surface zero) measured along the fallout axis to the 200 roentgen contour.	The 200 roentgen contour represents a total radiation dose of 200 roentgens within 48 hours after detonation. This is sufficient radiation to produce casualties.

$QL_aL_aL_oL_o$ Tddss DDDDD Tddss DDDDD

0 2 8 7 5 12836 0 0 0 1 7 42376 0 0 3 0 0

The above is an example of the pre-burst prediction message and the symbolic format.

$QL_aL_aL_oL_o$

0 2 8 7 5

0—means that the point for which the forecast is made is located in the Northern Hemisphere between 0° and 90°W.

28—means that the latitude of the forecast point is 28°N.

75—means that the longitude of the forecast point is 75°W.

Tddss **DDDDD**

12836 **0 0 0 1 7**

These two groups contain low-yield information.

1—means that the fallout area for a low-yield weapon is in the shape of the pattern of template ALFA (see figure 3-7-1).

28—indicates that the low-yield effective fallout wind is from 280°.

36—this is the low-yield effective fallout wind speed in knots.

00017—this is the greatest distance downwind that would receive 200 roentgens within 48 hours with a low-yield weapon. The distance in this case is 17 nautical miles.

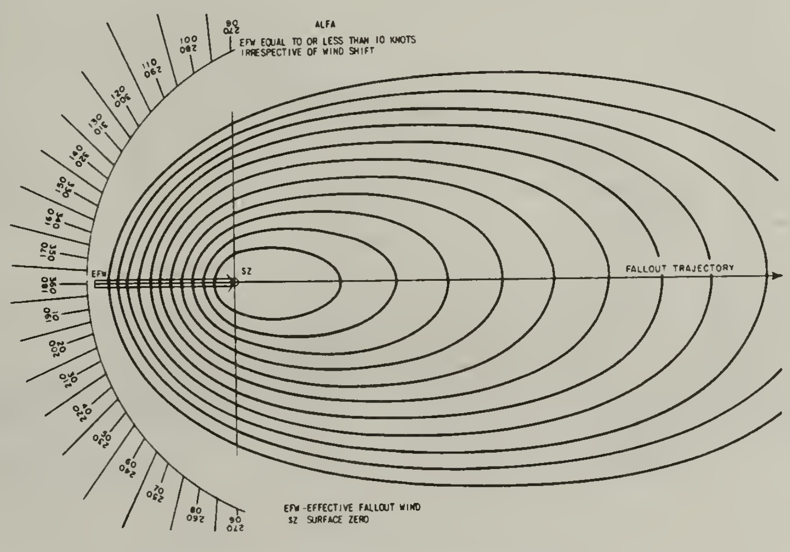


Figure 3-7-1.—ALFA template.

Tddss	DDDDD
42776	00300

These two groups contain high-yield information.

4—means that the fallout area for a high-yield weapon is in the shape of the pattern of template DELTA

27—indicates that the high-yield effective fallout wind is from 270°.

76—this is the high-yield effective fallout wind speed in knots.

00300—this is the greatest distance downwind that would receive 200 roentgens within 48 hours if the weapon were of high-yield. In this case, the distance is 300 nautical miles.

The pre-burst prediction message is computed for every five degrees latitude and longitude and when transmitted the data for each point is printed out one below the other. The message below is an exact copy of part of an actual message.

PRE-BURST PREDICTION 24 HR FCST FROM 12Z 04 JAN 76

FORMAT	QLLLL	Tddss	DDDDD	Tddss	DDDDD
04075	22439	00018	52435	00214	
04080	22636	00018	32632	00205	
04085	43117	00013	23116	00145	
04090	22614	00012	22720	00184	
14595	22545	00019	52541	00230	

CONSTRUCTION OF A RADFO DIAGRAM

To construct a RADFO diagram, you use the following materials.

1. Plastic overlay
2. Red and black grease pencils
3. The proper RADFO template as determined from the message (See figure 3-7-1, 3-7-2, and 3-7-3)
4. The nautical mile scale from the weather plotting chart (See figure 3-7-4)

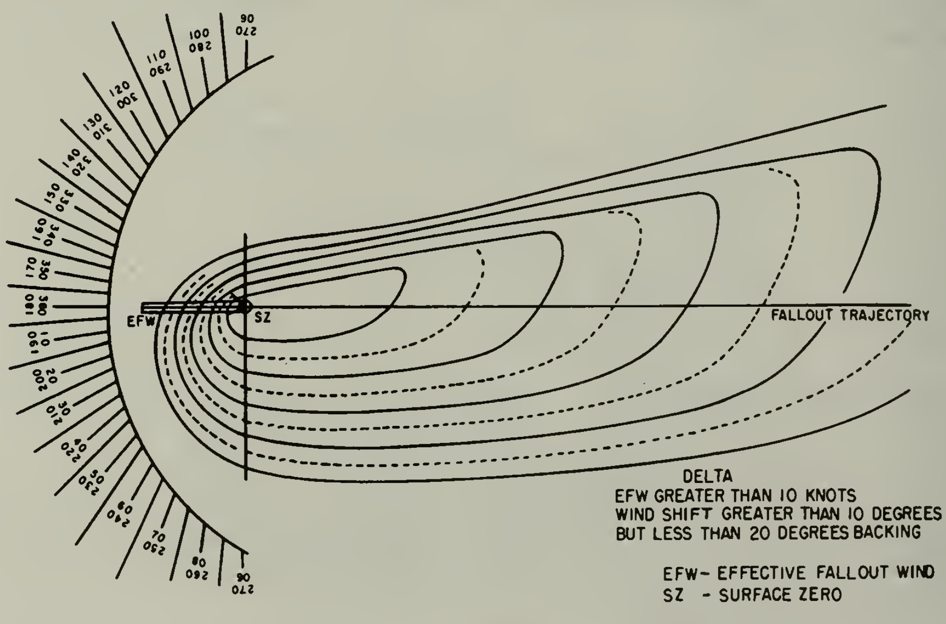


Figure 3-7-2.—DELTA template.

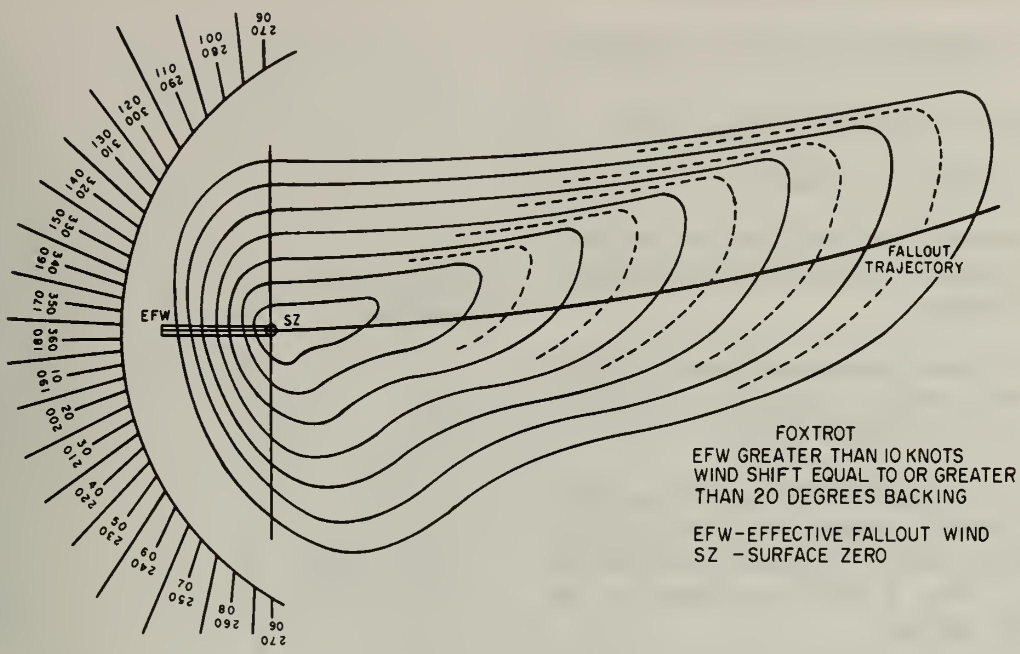


Figure 3-7-3.—FOXTROT template.

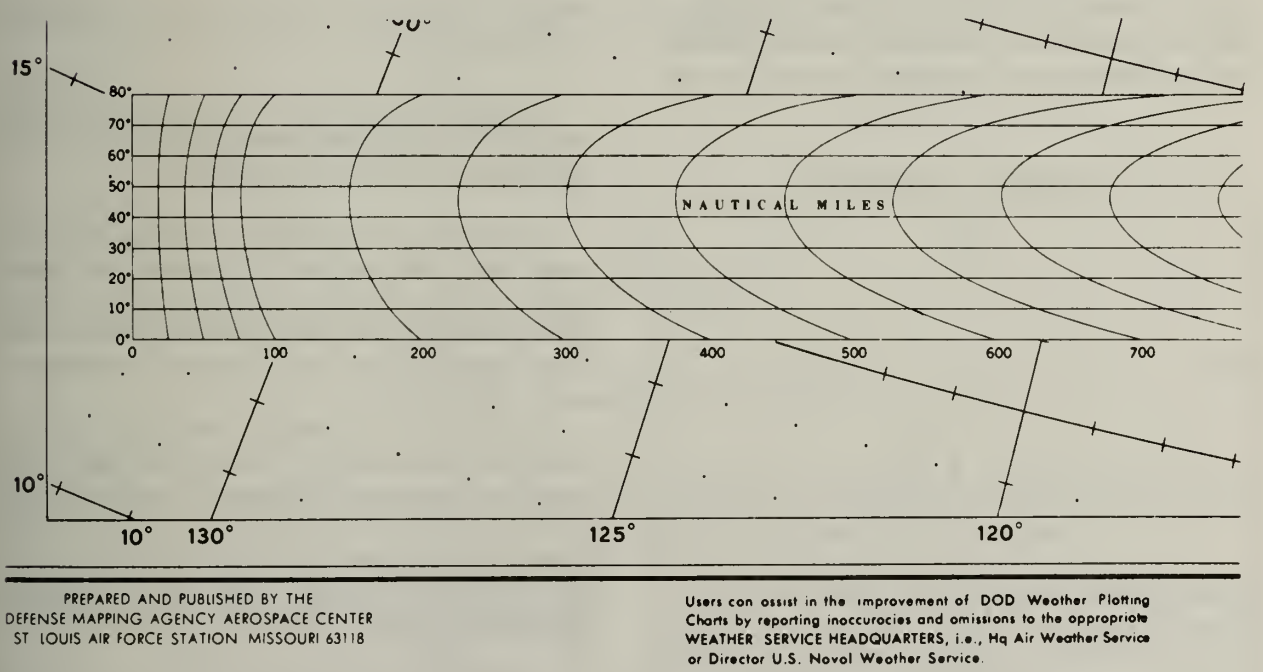


Figure 3-7-4.—Plotting chart distance scale.

5. A pre-burst prediction message

PRE-BURST PREDICTION, 24 HR FCST FROM 12Z 05 JAN 82

FORMAT QLLLL Tddss DDDDD Tddss DDDDD

04075 13230 00016 12760 00270

The following two steps must be completed before you begin to construct either the high- or low-yield diagram.

1. With a black grease pencil mark a small x in the center of the plastic overlay and label it SZ (surface zero). (See figure 3-7-5.)

2. Draw a straight line through SZ and label the ends N and S to indicate true north and true south on the overlay. To assist further in the orientation, draw a small arrowhead on the north end of the line.

To construct the low-yield fallout plot, you:

(1) Select a template indicated by the RADFO message for the low-yield trajectory. (RADFO templates are nothing more than various standard patterns of contoured lines which are used to outline the low-yield and high-yield fallout areas.)

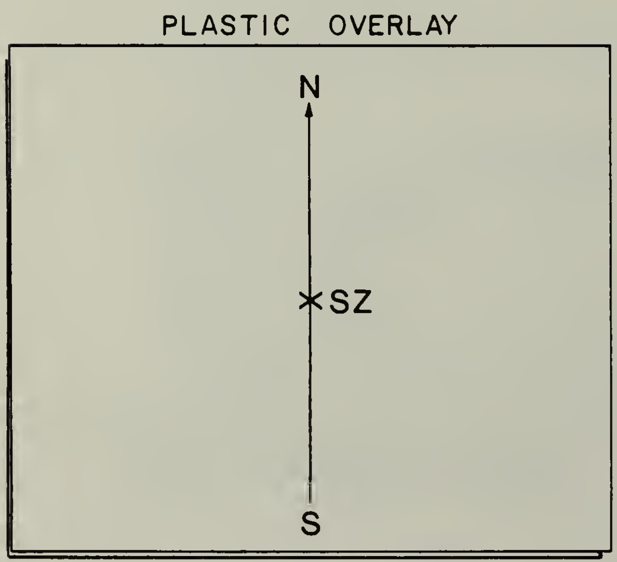


Figure 3-7-5.—Plastic overlay.

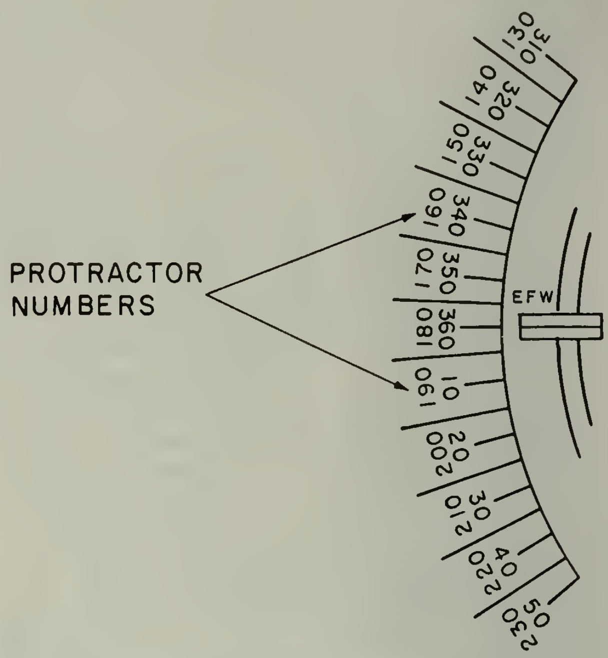


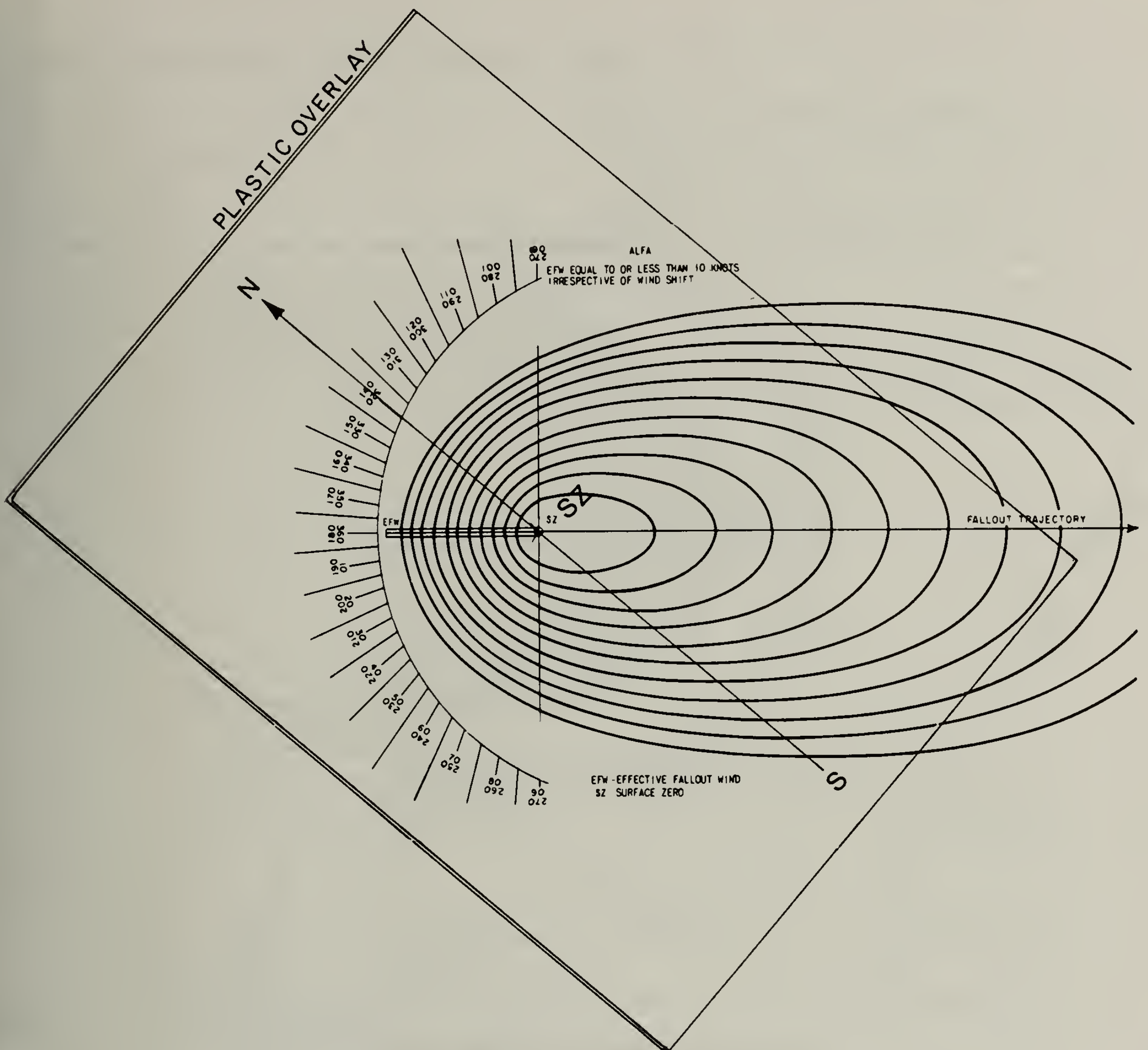
Figure 3-7-6.—Protractor numbers.

(2) Place the plastic overlay on the template with the SZ of the template (ALFA) and the SZ of the plastic overlay coinciding.

(3) Rotate the overlay until the N-S line aligns with the protractor number (see figure 3-7-6) of the template corresponding to the *direction of the low-yield effective fallout wind* taken from the pre-burst prediction message.

What you are trying to determine here is, once the bomb goes off, where will the winds carry the radioactive fallout? To determine this on the diagram, you must use the wind direction given in the message to determine which end of the N-S line is placed over the appropriate protractor number. The rules for this are:

a. If the wind direction given in the message falls within the North semicircle (270°-360°-090°), the *N end* of the N-S line will be placed over the number on the protractor (*inside row*)



209.448

Figure 3-7-7.—Example: Wind is from 320°.

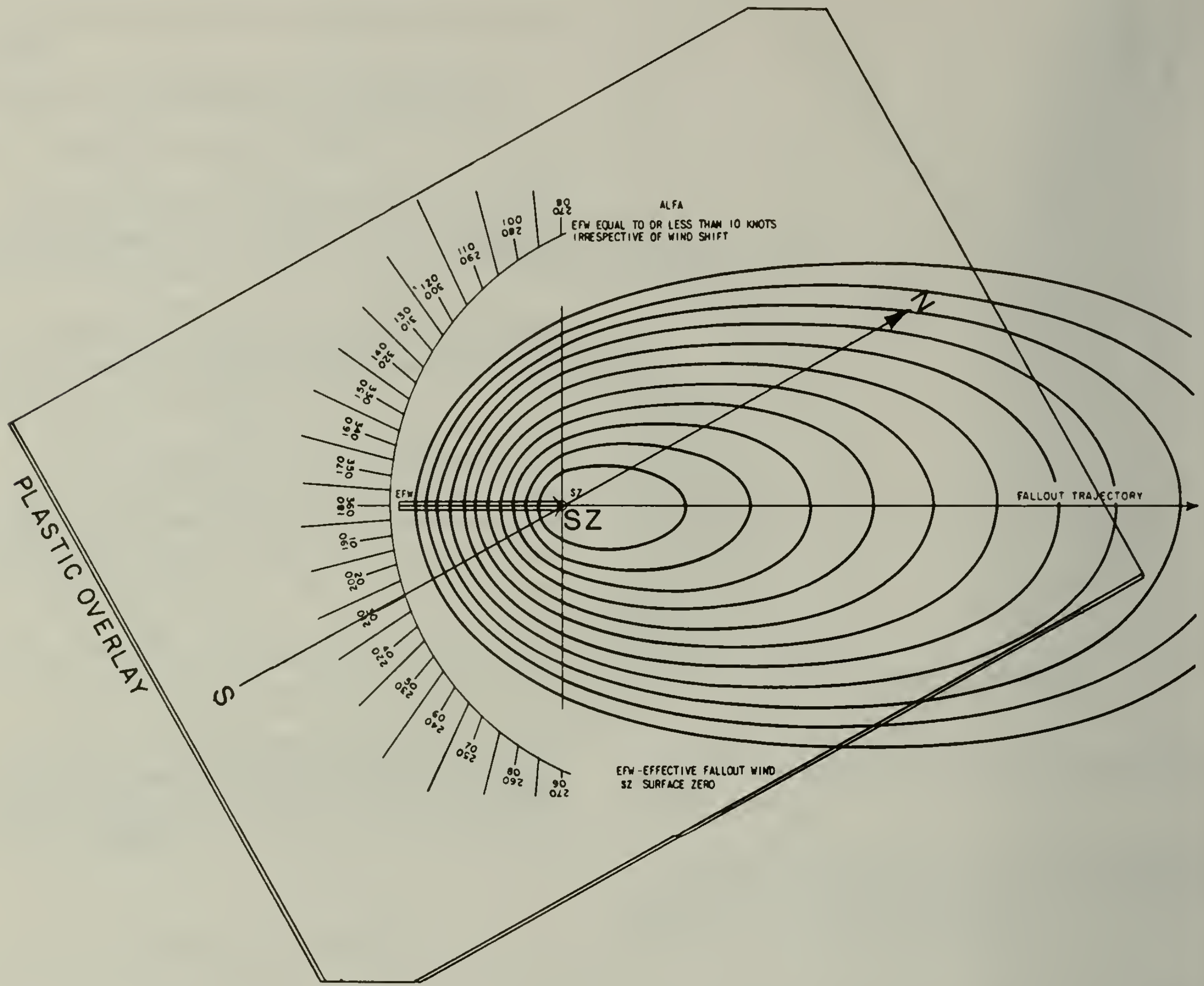
corresponding to the wind direction. (See figure 3-7-7 for example.)

b. If the wind direction is within the South semicircle (090°-180°-270°), the *S end* of the N-S line is placed over the number on the protractor (*outside row*) corresponding to the wind direction. (See figure 3-7-8.)

c. If the wind direction given in the message is from exactly 270°, place the *N end* of the N-S line over the 270 protractor number (*inside row*) at the *top* of the template.

d. If the wind direction given in the message is from exactly 090°, place the *S end* of the N-S line over the 090 protractor number (*outside row*) at the *top* of the template.

(4) Next you must mark off the downwind distance along the fallout trajectory line of the



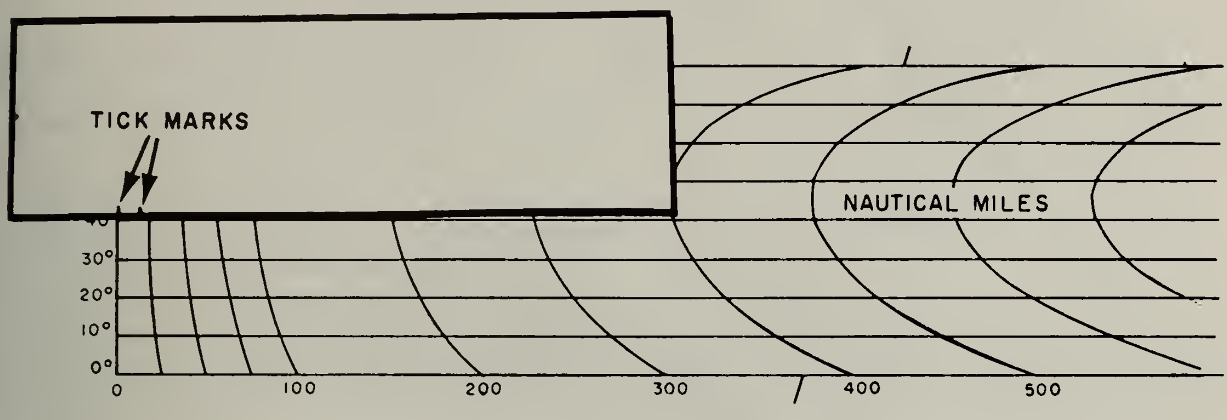
209.449

Figure 3-7-8.—Example: Wind is from 210°.

template. The low-yield DDDDD group of the message gives the distance in nautical miles, but you must determine the distance for the particular chart you are using. To do this, look at the scale printed on the chart, (see figure 3-7-9), generally located at the base of the chart. Notice that the scale has latitude printed along the left side and nautical miles printed across the bottom. To figure your downwind distance, align a piece of blank paper along the line representing the latitude of the RADFO plot (40° in this case). Then, move out along the latitude line until you find the distance that is encoded for the low-yield DDDDD (16 nm). Put small tick marks on the blank piece of paper at 0 miles and 16 miles. The distance between these two marks represents the downwind distance at 40°N.

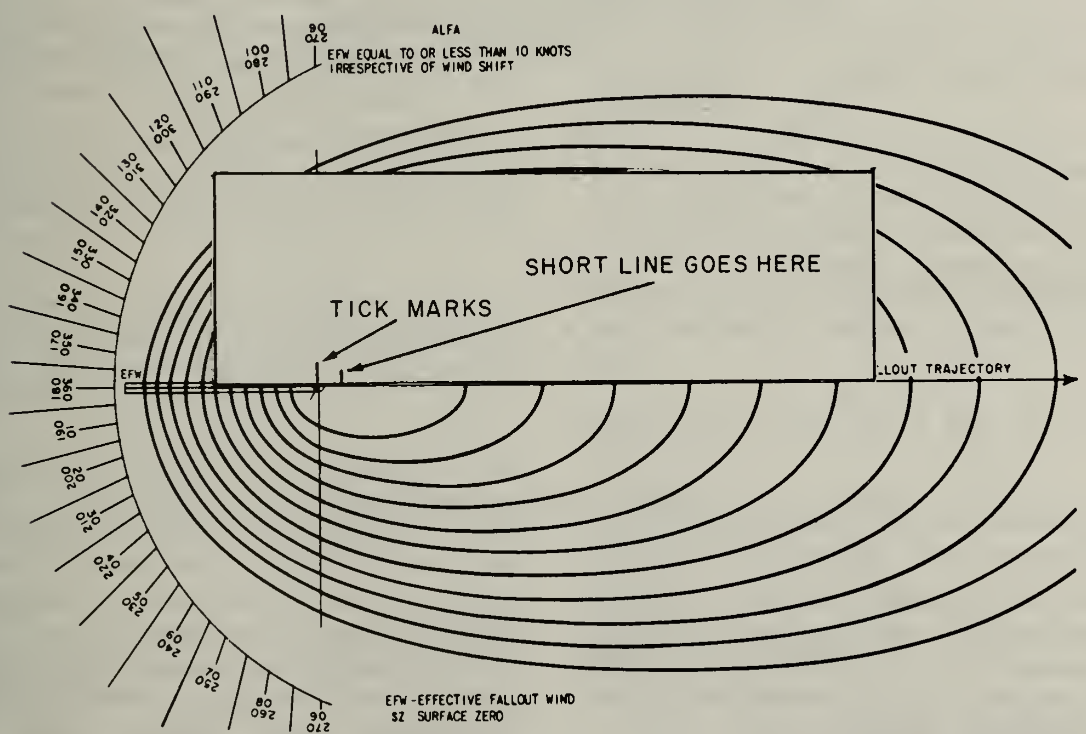
(5) Now align the piece of blank paper along the fallout trajectory line of the template with the left tick mark on the paper at point SZ. Where the second tick mark lies, make a short line with the *red* grease pencil on the plastic overlay. (See figure 3-7-10.)

(6) The last step in plotting the low-yield section of the RADFO message is to outline the



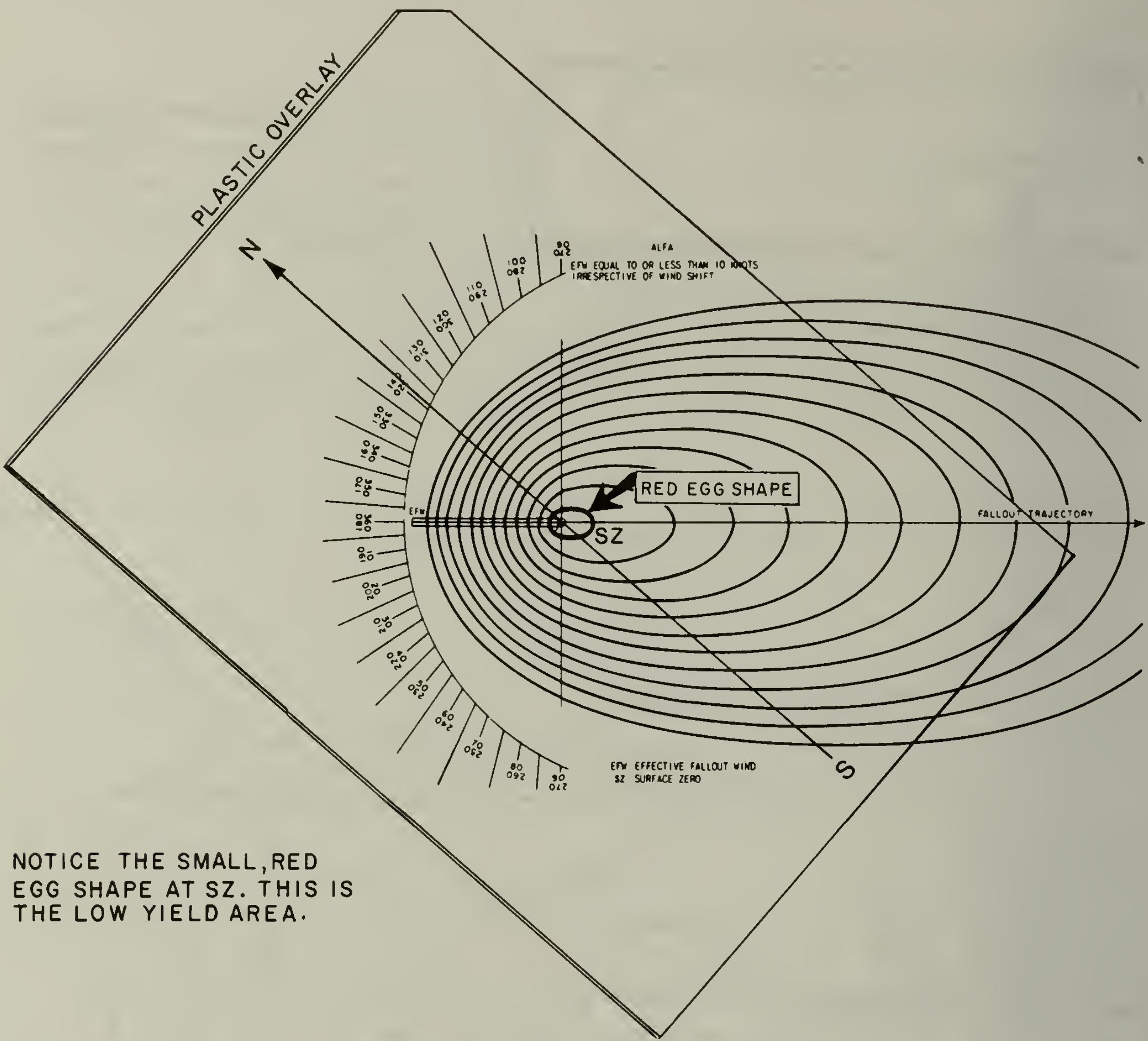
209.450

Figure 3-7-9.—Measuring distance on scale.



209.451

Figure 3-7-10.—Applying distance to template.



209.452

Figure 3-7-11.—Drawing low yield contour on plastic overlay.

complete low-yield fallout area. To do this, you start from the point that represents the downwind distance, and draw a contour concentric with the contours on the template using a *red* grease pencil. (See figure 3-7-11.)

Now your low-yield plot is all prepared. If a low-yield nuclear weapon should be set off in the area of 40°N 75°W you would immediately orientate the overlay's N-S line with the meridian (N-S lines) of the plotting chart you had used and put the S-Z point of the overlay exactly over the actual point of detonation. The area covered by the low-yield plot should receive enough radiation within 48 hours to produce casualties. A complete RADFO diagram consists of the low-yield *and* high-yield fallout plots. The procedures for plotting the high-yield are also identical to those used to find the low-yield.

(1) Refer to the RADFO message and select the template for the high-yield trajectory.

The low- and high-yield templates are often different.

PRE-BURST PREDICTION 24 HR FCST FROM 12Z 04 JAN 76

FORMAT QLLLL Tddss DDDDD Tddss DDDDD

04075 13230 00016 12760 00270

(2) Align the overlay and the template in the same manner as you did with the low-yield. Remember, if the wind direction is 090-180-270, you put the S end of the N-S line over the protractor, and if the wind direction is between 270-360-090, you put the N end of the N-S line over the protractor.

(3) Next, using the downwind distance given in the high-yield DDDDD determine the actual distance. Mark this distance off on a blank piece of paper as you did for the low-yield weapon.

(4) Align the paper along the fallout trajectory as was done for the low-yield. Now mark off the downwind distance for high-yield on the plastic overlay.

(5) Outlining the high-yield fallout area is done in the same manner as with the low-yield, except that the contour is drawn with a *black* grease pencil.

The completed plastic overlay that will now show low (red) and high (black) contour line readings away from the point of detonation. (See figure 3-7-12 for example.)

To complete a RADFO plot, a legend block should be made. This will tell the forecaster the essential information about the plot. This information should be updated for every new plot.

In one corner of the overlay, print the following legend.

Location:________________________
Beginning Time:____________________
Ending Time:______________________
Map:____________________________
Plotter:_________________________

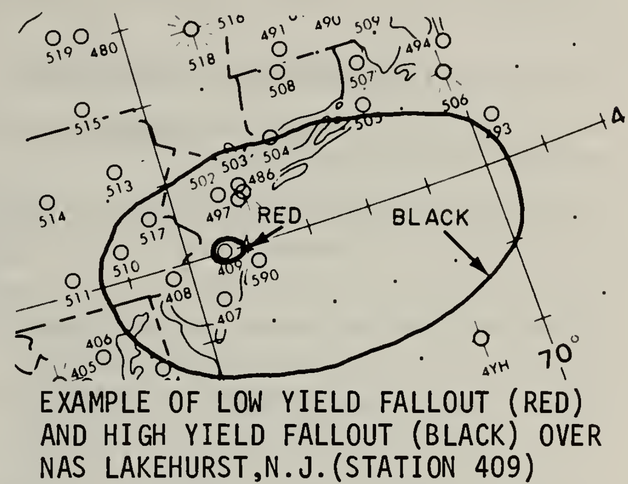


Figure 3-7-12.—Example of low and high yield fallout areas.

For location, write in the latitude and longitude of the forecast point.

Beginning time is obtained from the heading of the message.

For ending time, you must add the number of hours the forecast is valid from the beginning time—usually 24 hours.

The map number from which the distance scale was obtained is written in beside the word MAP.

Finally print your name next to the word "Plotter".

This data block must be on every overlay or the overlay is of no value. The forecaster cannot just guess at the position.

FALLOUT WARNING

The pre-burst prediction messages that you have been working with are probably the only type of radiological fallout message you will ever see. But remember, there were two types of RADFO messages. The second type, called a *Fallout Warning*, is transmitted only after a nuclear weapon has been detonated.

The format for the fallout warning message is:

$QL_aL_aL_oL_o$ YYGG/YYYYY Tddss DDDDD

As you can see, the format has many elements similar to the pre-burst format.

The **$QL_aL_aL_oL_o$** group is the encoded position of the weapon's detonation point.

In this situation you will know the actual point of detonation and the message will not be made up for every five degrees latitude and longitude.

YYGG—This is a new group but it is relatively simple to understand.

YY—Is the day of the month.

GG—Is the time in GMT of the detonation of the weapon. *Remember this is not a forecast starting at a given time. The time used for all calculations is the actual time the weapon went off.*

The **YYYYY** group gives the actual yield of the weapon in kilotons. The group is always encoded as 5 digits.

Once again this message is for an actual blast, you do not have to guess at the weapon's size.

The **Tddss** group is the same as in the pre-burst prediction message—i.e. fallout template and effective fallout wind. This is based on actual and forecast winds over the appropriate time period.

The **DDDDD** group is also the same; it gives the distance in nautical miles from surface zero to the 200 roentgen contour.

Of course a RADFO plot can be constructed from a fallout warning message just the same as from a pre-burst prediction message, but you will *only* be required to *decode* fallout warning messages.

EXERCISE (3-7-1)

PRE-BURST PREDICTION 24 HR FCST FROM 12Z 04 JAN 76

FORMAT QLLLL Tddss DDDDD Tddss DDDDD

04075	22439	00018	52435	00214
04085	22636	00018	32632	00205
14095	43117	00013	23116	00145
14005	22614	00012	22720	00184
04575	22545	00019	52541	00230

1. Using the above message answer the following questions.

   a. When does the forecast period begin?__________

   b. What is the latitude and longitude of the first forecast point? __________°__________°

   c. What are the low and high templates for 40°N 95°W?__________

   d. What is the low and high yield downwind distances for 40°N, 105°W?__________NM__________NM

   e. What is the low yield effective fallout wind for 40°N 105°W? __________°__________kts

   f. What is the low and high yield downwind distance for 40°N 85°W?__________NM__________NM

   g. Completely decode the last forecast point of the message.
   Position__________°N__________°W
   Low yield template__________
   Low yield effective fallout wind__________°__________kts
   Low yield downwind distance__________NM
   High yield template__________
   High yield effective fallout wind__________°__________kts
   High yield downwind distance__________NM

   h. For how many hours is the forecast good?__________

2. Decode the following fallout warning message.

   FALLOUT WARNING
   03776 1813/ 10000 62185 00430

   What is the

   a. Time of detonation__________

   b. Location of the burst__________

   c. Yield of the weapon__________

   d. Downwind distance__________

UNIT 3—LESSON 8

UPPER AIR REPORTS

OVERVIEW

Identify the procedure for decoding and encoding upper air observation reports.

OUTLINE

Composition of the reports

Standard hours of observations

Reporting individual parts and sections

Corrections

Missing data

Distribution of reports

Example of coded messages

UPPER AIR REPORTS

The radiosonde upper air code was established to provide specific coding instructions and reporting procedures for all meteorological stations taking upper air observations.

The upper air reports are designed to report pressure, temperature, humidity, and wind conditions in the upper atmosphere. This coded format is then fed into the computers for generating upper air charts, analysis, and prognosis. It also provides data for many other types of meteorological forecast.

Learning Objective: Identify the procedures for decoding and encoding upper air reports.

The radiosonde code serves as a type of shorthand to the aerographers. You can take the information from a radiosonde and transmit it to other stations in a very short time. This can be done without any sacrifice in the accuracy of the usable data. Different sections of the world use basically the same code, but with minor variations. You will have to become familiar with the code for all the WMO regions because of having to move from one location to another. You will also have to rely on reports from other regions of the world for weather data. The code is contained in FMH-4, *RADIOSONDE CODE*, NAVAIR 50-1D-4. Agencies of the U.S. Naval Oceanography Command uses one standard set of coding instructions to promote uniformity in coding and transmission.

Normally, military stations follow the procedures for the WMO region in which they are located unless otherwise authorized.

However, data for the mandatory levels (listed in a later section of the lesson) are reported whenever available by all Naval Oceanography Command units regardless of the regional procedure. These levels are considered to be the minimum requirement and in no way prohibit the reporting of data for such other pressure surfaces as may be required by applicable regional procedures.

COMPOSITION OF THE REPORTS (MESSAGE)

The WMO defines a meteorological message as comprising a single meteorological bulletin preceded by a starting line and followed by the end of transmission signal.

The upper air report, shown in figure 3-8-1, is composed of figure groups, each group having five figures. Each figure in each group is significant to its position in the group and to its position in the message following the section indicator or a particular self-identifying group. Therefore, the established order of the groups in the message will be maintained as indicated in the symbolic order or as specified in the instructions outlined in FMH-4.

When observed data is not available for an element, the appropriate code figure or missing indicator (/) will be reported. This is done to preserve continuity of the group, or a number of the groups, or section, as required.

Due to communication arrangements that may be in effect for your particular station, it is not practicable to specify precisely the amount of data to be transmitted.

Shipboard stations will transmit PARTS A, B, C, and D, insofar as data are available. Whether all the parts are included in a single message, or the PARTS are divided into several messages, will depend upon a number of factors which fluctuate from day to day.

PARTS A and C have first transmission priority, with PARTS B and D having second transmission priority.

STANDARD HOURS OF OBSERVATION

The WMO standard times of upper-air soundings taken for synoptic purposes are 0000, 0600, 1200, and 1800 GMT.

If only two upper-air soundings are taken per day for synoptic purposes, they will be taken at 0000 and 1200 GMT.

If more than two upper-air soundings are taken per day for synoptic purposes, the ones additional to those taken at 0000 and 1200 GMT will be taken at 0600 and/or 1800, as directed.

If only one upper-air sounding is taken per day for synoptic purposes, it will be taken at either 0000 or 1200 GMT.

Occasionally special instructions are issued regarding upper-air soundings to be taken in connection with special projects, the passage of

```
TTAA 55121 72403 99004 10666 30510 00122 09665 31011 85436 02361
33518 70969 05367 26018 50554 21162 24553 40714 34360 23554 30910
463// 24085 25030 511// 23585 20175 503// 24055 15362 521// 24045
10621 581// 22029 88241 521// 23085 77246 23586 41329

TTBB 5512/ 72403 00004 10666 11873 01558 22776 05750 33762 03368
44746 02767 55650 08567 66598 12758 77576 13962 88440 29163 99366
38160 11300 463// 22241 521// 33200 503//

TTCC 55122 72403 70851 567// 23008 50060 529// 24002 30391 517//
24013 20652 537// 24018 10103 471// 24030 88999 77999

TTDD 5512/ 72403 11900 581// 22570 561// 33500 529// 44200 537//
55080 451// Ⓘ
```

Figure 3-8-1.—Complete RAWINSONDE message.

severe storms, hurricanes, etc. Upper-air soundings taken in support of these special projects, or required by the storm conditions, will be taken at the times specified in the authorizations issued to the stations involved.

REPORTING INDIVIDUAL PARTS AND SECTIONS

The WMO has clearly set forth the form of message and reporting procedures to be followed with respect to the data that must be included in reports exchanged on a hemispheric basis. For convenience in specifying the reporting procedures to be followed, the form of message has been subdivided into PARTS and Sections. The PARTS, four in number and identified as A, B, C, and D, are the larger subdivision, and they are referred to in identifying the Sections (i.e., the types of data) to be included in a particular message· or a collective. The Sections are the smaller subdivision, and they refer to a particular type of data and the precise form of message to be used in coding the data. The Sections are numbered 1 through 10 for easy reference. When considered in reverse order, it will be noted that a Section is unique and has the same form and reports the same type of data regardless of the PART in which it appears. Further, each PART is merely an assemblage of specified Sections. Likewise, a PART is unique with respect to the type of data it contains, as specified by the Sections included in it, and the portion of the atmosphere it covers.

NOTE: As the U.S. uses only Sections 1, 2, 3, 4, 5, and 9 of the complete WMO Code Form, instructions regarding the use of Sections 6, 7, 8 and 10 have been omitted. Information on Sections 6, 7, 8 and 10 is given only in Division D of FMH-4.

PARTS A, B, C, and D

For reporting purposes, the PARTS divide the atmosphere horizontally into two portions at the 100-mb surface. Only data at and below 100 mb are reported in PARTS A and B. Only data above 100 mb are reported in PARTS C and D. PARTS A and C provide for coding the same type of data in the same form as follows: Identification-Position (Section 1), Standard isobaric surfaces (Section 2), Tropopause Data (Section 3), and Maximum Wind Data (Section 4). The one exception is Surface Data which is reported in PART A but not in PART C. PARTS B and D provide for reporting the same type of data in the same form as follows: Identification-Position (Section 1), Significant Levels with respect to Temperature and/or Humidity (Section 5), and Regional Codes-Additional Data (Section 9). The one exception is Surface Data which are reported in PART B but not in PART D.

The reporting of a PART is mandatory when any data required by that PART are available.

The forms of messages for both land and shipboard stations are identical with the exception of the Identification-Position groups (i.e., Section 1). The land station report is positioned by means of the index number whereas the shipboard station report uses geographic coordinates for positioning. For land station reporting of separate PARTS, the index number group in Service C transmissions appears twice.

The symbolic forms of messages of the four parts (A, B, C, and D) of the complete report are given in figure 3-8-2 for a land station and in figure 3-8-3 for a shipboard station.

Definitions of Symbolic Symbols

This section will cover the definitions of the symbolic symbols (elements and groups) as listed in figures 3-8-2 and 3-8-3 in the same general order in which they appear.

The elements will be given as they appear in the land station and covering special instructions, if required, for the coding of the shipboard elements.

The WMO has assigned the code name TEMP to the report of an upper-air sounding (i.e., upper-level pressure, temperature, humidity, and wind) from a land station. The code name TEMP SHIP has been assigned to the report of an upper-air sounding from a shipboard station. These code names have been assigned for reference purposes only so the form and content of the report will be precisely identified by use of the code name. These code names are never included in the individual coded report.

PART A

Form of Message	Contents
	[Data up to and including 100 mb]
TTAA YYGGI$_d$ IIiii	[Identification-Position]** [Section 1]
99P$_o$P$_o$P$_o$ T$_o$T$_o$T$_{ao}$D$_o$D$_o$ d$_o$d$_o$f$_o$f$_o$f$_o$	[Surface Data]
00hhh TTT$_a$DD ddfff	[Standard Isobaric Surfaces] [Section 2]
85hhh TTT$_a$DD ddfff	
70hhh TTT$_a$DD ddfff	
50hhh TTT$_a$DD ddfff	
40hhh TTT$_a$DD ddfff	
30hhh TTT$_a$DD ddfff	
25hhh TTT$_a$DD ddfff	
20hhh TTT$_a$DD ddfff	
15hhh TTT$_a$DD ddfff	
10hhh TTT$_a$DD ddfff	
88P$_t$P$_t$P$_t$ T$_t$T$_t$T$_{at}$D$_t$D$_t$ d$_t$d$_t$f$_t$f$_t$f$_t$ or 88999	[Tropopause Data]* [Section 3]
77 or 66 P$_m$P$_m$P$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ ① or 77999 ①	[Maximum Wind Data]* [Section 4]

PART B

Form of Message	Contents
	[Data up to and including 100 mb]
TTBB YYGG/ IIiii	[Identification-Position]** [Section 1]
00P$_o$P$_o$P$_o$ T$_o$T$_o$T$_{ao}$D$_o$D$_o$	[Surface Data]
11PPP TTT$_a$DD	[Significant Levels with respect to Temperature and/or Humidity] [Section 5]
22PPP TTT$_a$DD	
33PPP TTT$_a$DD	
44PPP TTT$_a$DD	
.... etc.	
51515 101A$_{df}$A$_{df}$ ①	[Regional Codes—Additional Data] [Section 9]

PART C

Form of Message	Contents
	[Data above 100 mb]
TTCC YYGGI$_d$ IIiii	[Identification-Position]** [Section 1]
70hhh TTT$_a$DD ddfff	[Standard Isobaric Surfaces] [Section 2]
50hhh TTT$_a$DD ddfff	
30hhh TTT$_a$DD ddfff	
20hhh TTT$_a$DD ddfff	
10hhh TTT$_a$DD ddfff	
07hhh TTT$_a$DD ddfff	
05hhh TTT$_a$DD ddfff	
03hhh TTT$_a$DD ddfff	
02hhh TTT$_a$DD ddfff	
01hhh TTT$_a$DD ddfff	
88P$_t$P$_t$P$_t$ T$_t$T$_t$T$_{at}$D$_t$D$_t$ d$_t$d$_t$f$_t$f$_t$f$_t$ or 88999	[Tropopause Data]* [Section 3]
77 or 66 P$_m$P$_m$P$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ ① or 77999 ①	[Maximum Wind Data]* [Section 4]

PART D

Form of Message	Contents
	[Data above 100 mb]
TTDD TTGG/ IIiii	[Identification-Position] [Section 1]
11PPP TTT$_a$DD	[Significant Levels with respect to Temperature and/or Humidity] [Section 5]
22PPP TTT$_a$DD	
33PPP TTT$_a$DD	
44PPP TTT$_a$DD	
.... etc.	
51515 101A$_{df}$A$_{df}$ ①	[Regional Codes—Additional Data] [Section 9]

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Figure 3-8-2.—Land station (TEMP) symbolic forms.

PART A — *Form of Message*	*Contents* [Data up to and including 100 mb]
UUAA YYGGI$_d$ 99L$_a$L$_a$L$_a$ Q$_c$L$_o$L$_o$L$_o$L$_o$ MMMU$_{La}$U$_{Lo}$	[Identification-Position] [Section 1]
99P$_o$P$_o$P$_o$ T$_o$T$_o$T$_{ao}$D$_o$D$_o$ d$_o$d$_o$f$_o$f$_o$f$_o$	[Surface Data]
00hhh TTT$_a$DD ddfff 85hhh TTT$_a$DD ddfff 70hhh TTT$_a$DD ddfff 50hhh TTT$_a$DD ddfff 40hhh TTT$_a$DD ddfff 30hhh TTT$_a$DD ddfff 25hhh TTT$_a$DD ddfff 20hhh TTT$_a$DD ddfff 15hhh TTT$_a$DD ddfff 10hhh TTT$_a$DD ddfff	[Standard Isobaric Surfaces] [Section 2]
88P$_t$P$_t$P$_t$ T$_t$T$_t$T$_{at}$D$_t$D$_t$ d$_t$d$_t$f$_t$f$_t$f$_t$ or 88999	[Tropopause Data] [Section 3]
77 or 66 } P$_m$P$_m$P$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ ① or 77999 ①	[Maximum Wing Data] [Section 4]

PART B — *Form of Message*	*Contents* [Data up to and including 100 mb]
UUBB YYGG/ 99L$_a$L$_a$L$_a$ Q$_c$L$_o$L$_o$L$_o$L$_o$ MMMU$_{La}$U$_{Lo}$	[Identification-Position] [Section 1]
00P$_o$P$_o$P$_o$ T$_o$T$_o$T$_{ao}$D$_o$D$_o$	[Surface Data]
11PPP TTT$_a$DD 22PPP TTT$_a$DD 33PPP TTT$_a$DD 44PPP TTT$_a$DD .... etc.	[Significant Levels with respect to Temperature and/or Humidity] [Section 5]
51515 101A$_{df}$A$_{df}$ ①	[Regional Codes—Additional Data] [Section 9]

PART C — *Form of Message*	*Contents* [Data above 100 mb]
UUCC YYGGI$_d$ 99L$_a$L$_a$L$_a$ Q$_c$L$_o$L$_o$L$_o$L$_o$ MMMU$_{La}$U$_{Lo}$	[Identification-Position] [Section 1]
70hhh TTT$_a$DD ddfff 50hhh TTT$_a$DD ddfff 30hhh TTT$_a$DD ddfff 20hhh TTT$_a$DD ddfff 10hhh TTT$_a$DD ddfff 07hhh TTT$_a$DD ddfff 05hhh TTT$_a$DD ddfff 03hhh TTT$_a$DD ddfff 02hhh TTT$_a$DD ddfff 01hhh TTT$_a$DD ddfff	[Standard Isobaric Surfaces] [Section 2]
88P$_t$P$_t$P$_t$ T$_t$T$_t$T$_{at}$D$_t$D$_t$ d$_t$d$_t$f$_t$f$_t$f$_t$ or 88999	[Tropopause Data] [Section 3]
77 or 66 } P$_m$P$_m$P$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ ① or 77999 ①	[Maximum Wind Data] [Section 4]

PART D — *Form of Message*	*Contents* [Data above 100 mb]
UUDD YYGG/ 99L$_a$L$_a$L$_a$ Q$_c$L$_o$L$_o$L$_o$L$_o$ MMMU$_{La}$U$_{Lo}$	[Identification-Position] [Section 1]
11PPP TTT$_a$DD 22PPP TTT$_a$DD 33PPP TTT$_a$DD 44PPP TTT$_a$DD .... etc.	[Significant Levels with respect to Temperature and/or Humidity] [Section 5]
51515 101A$_{df}$A$_{df}$ ①	[Regional Codes—Additional Data] [Section 9]

209.488

Figure 3-8-3.—Shipboard (TEMP SHIP) symbolic forms.

Identification-Position (Section 1)

Section 1 contains identification of the code form and PART being reported, day and time of observation, information on the unit of wind speed being used, information on the number of standard isobaric surfaces for which wind data are reported, and the position of the station or location of the point of observation.

TTAA YYGGI$_d$ IIiii (land)

UUAA YYGGI$_d$ 99L$_a$L$_a$L$_a$ Q$_c$L$_o$L$_o$L$_o$L$_o$

MMMUL$_a$UL$_a$ (shipboard)

All groups (land or shipboard) of this section are always reported in PARTS A, B, C, and D when used.

Definitions of the symbolic letters or numbers for Section 1 are:

NOTE: The code tables used in each figure are inference to the code tables taken from FMH-4.

TT identifier letters are used to specify an upper air report from a land station using code table 108 (shown in figure 3-8-4).

UU identifier letters are used to specify an upper air report from a shipboard station using code table 108 (shown in figure 3-8-4).

AA identifies PART A of an upper air report from either a land or shipboard station. Information contains standard isobaric surfaces from the surface up to and including the 100-mb level (shown in figure 3-8-4).

BB identifies PART B of an upper air report from either a land or shipboard station. Information contains significant levels from the surface up to and including the 100-mb level (shown in figure 3-8-4).

CC identifies PART C of an upper air report from either a land or shipboard station. Information contains standard isobaric surfaces above the 100-mb level (shown in figure 3-8-4).

Code Table 108

[WMO Code 2582]

Name of Code Form	M_iM_i (Code Form)	M_jM_j (PART of Code Form)			
		PART A	PART B	PART C	PART D
PILOT (FM 32.V)	PP	AA	BB	CC	DD
PILOT SHIP (FM 33.V)	QQ	AA	BB	CC	DD
TEMP (FM 35.V)	TT	AA	BB	CC	DD
TEMP SHIP (FM 36.V)	UU	AA	BB	CC	DD

Figure 3-8-4.—Message identifier letters.

DD identifies PART D of an upper air report from either a land or shipboard station. Information contains significant levels above the 100-mb level (shown in figure 3-8-4).

For example: The four-letter group for PART A of a Radiosonde Report from a land station will be TTAA; for PART B the group will be TTBB, etc. The four-letter group for PART A of a Radiosonde Report from shipboard station will be UUAA; for PART B, the group will be UUBB, etc.

YY indicates the day of the month, according to GMT on which the observation is taken and the unit of wind speed (knots or meters per second) being used. Thus both parameters are involved in determining the value to be reported for YY.

The day of the month is indicated by the use of a code number 01 to 31, inclusive, where code number 01 means the 1st day of the month and code number 02 means the 2nd day, etc.

YY is also an indication for the unit of speed being used to report all the wind speeds given in the message and is indicated as one of the following:

Knots. When the knot is used for the unit speed, 50 is added to the code number selected for the day of the month, and the sum is coded for YY. For example: On the second day of the month (i.e., code number 02), add 50, and this makes the code number 52.

Meter per seconds. When MPS is used for the unit of wind speed, the code number selected for the day of the month is coded directly for YY without alteration.

NOTE: All U.S. and military stations will use the knot for the unit of wind speed.

GG identifies the time of observation in whole hours GMT. The twenty-four hour clock will be used (i.e., 00 to 23).

The time of release of the balloon to the nearest minute, entered on the winds aloft form, is the actual time of observation. International agreement on the time of observation specifies that the time of regular upper air observation should be as close as possible to H-30 (0530, 1130, 1730, and 2330) and should not fall outside the time range H-45 (0515, 1115, 1715, and 2315). H is referring to one of the four standard hours of observation (00, 06, 12, and 18 GMT). Therefore, if the balloon is released within the 45-minute time range, the appropriate standard hour will be reported for GG. For example: If the observation is taken between 1115 and 1200 GMT, inclusive, 12 will be reported for GG.

If the balloon is released outside the 45-minute time range, the nearest whole hour will be reported for GG. For example: 1030 to 1114, inclusive is coded 11; 1230 to 1329, inclusive is coded 13.

I_d indicates the last standard isobaric surface for which the wind group (ddfff) is reported in Section 2. The code figure is shown in figure 3-8-5. The reportable value will be inserted in the position specified for symbol I_d in Section 1 of PARTs A and C, as appropriate, in both the land and shipboard forms of messages.

Code Table 103

[WMO Code 1734]

Code figure	Wind group reported up to and including the following standard isobaric surfaces: PART A	PART C
1	100 or 150 mb[1]	10 mb
2	200 or 250 mb[2]	20 mb
3	300 mb	30 mb
4	400 mb	....
5	500 mb	50 mb
6	....	....
7	700 mb	70 mb
8	850 mb	....
9	....	....
0	1000 mb	....
/	No wind groups reported for any of the standard isobaric surfaces.	No wind groups reported for any of the standard isobaric surfaces.

Figure 3-8-5.—Code figure for symbol I_d.

Looking at figure 3-8-5, it can be seen that most of the code numbers have two specifications—one of which applies to PART A and the other applies to PART C. Therefore, the exact meaning of the specification depends on whether it applies to PART A or PART C. In PART A the code figure represents the hundreds digit of the millibar value of the last standard isobaric surface for which wind data are available. In PART C the code figure represents the tens digit of the millibar value of the last standard isobaric surface for which wind data are available. Each code figure represents a surface in each PART, except for code figures 1 and 2 in PART A where each represents two surfaces.

When wind data are available from the surface up to and including a standard isobaric surface, the code figure corresponding to that standard isobaric surface will be reported for I_d. Therefore, the wind group ddfff will appear in that PART of the report for all standard surfaces up to and including the surface indicated

by I_d, and it will be omitted for all standard surfaces above that surface. For example: If wind data for the entire ascent were obtained from the surface up to and including the 300-mb surface, symbol I_d would be coded and the ddfff group reported as follows:

1. In PART A, code figure 3 would be coded for I_d and the ddfff group included for the 1000-, 850-, 700-, 500-, 400-, and 300-mb surfaces with the ddfff group being omitted from the message for the 250-, 200-, 150-, and 100-mb surfaces.
2. In PART C, a solidus (/) would be coded for I_d, and the ddfff group would be omitted from the message for the 70-, 50-, 30-, 20-, 10-, 7-, 5-, 3-, 2-, and 1-mb surfaces.

With respect to the wind group (ddfff) in Section 2, each PART is considered independently for coding purposes with the code figure for I_d being selected only with respect to the amount of wind data being included in that PART. In other words only the number of standard surfaces from the surface for which wind data are available will be considered in selecting the code figure to be reported for I_d in PART A. Only the number of standard surfaces above 100 mb for which wind data are available will be considered in selecting the code figure to be reported for I_d in PART C.

Figure 3-8-5 provides for indicating the inclusion of the ddfff group only for the WMO worldwide standard isobaric surfaces; i.e., up to and including 10 mb. In WMO Region IV (i.e., North and Central America) the 7-, 5-, 3-, 2-, and 1-mb surfaces have been designated as regional standard isobaric surfaces; therefore, it has been necessary to make additional rules for indicating whether or not wind data are included for surfaces above the 10-mb surface. These rules are:

1. When one of the code figures 2 through 9 is reported for I_d in PART C, the ddfff group will be omitted for any surfaces above the 20-mb surface that are included in the report; i.e., for the 10-, 7-, 5-, 3-, 2-, and 1-mb surfaces.
2. When wind data are available for the 10-mb surface, regardless of the number of surfaces above the 10-mb surface for which wind data are available, code figure 1 will be reported for I_d, and the ddfff group will be included for any surfaces above the 10-mb surface that are included in the report; i.e., for the 7-, 5-, 3-, 2-, and 1-mb surfaces. In this case, five solidi (/////) will be reported for any of these surfaces above 10 mb for which wind data are not available.
3. When wind data are not available for the 1000-mb surface and all surfaces above it, a solidus (/) will be reported for I_d in both PARTS A and C and the ddfff group will be omitted for all standard surfaces, including the 1000-mb surface, in both PARTS.
4. The highest standard surface, with respect to geopotential height, for which wind data are available will be coded for I_d even though wind data are missing for one or more lower standard surfaces. The ddfff group will be included in the report for each of the standard surfaces covered by the code figure reported for I_d, with five solidi (/////) being coded for each of the ddfff groups for which data are missing. For example: If wind data are available for the 1000-, 850-, 700-, 300-, 250-, and 200-mb surfaces and missing for the 500- and 400-mb surfaces, code figure 2 will be coded for I_d, and the ddfff group will be included for all eight of these surfaces with five solidi (/////) being reported for the 500- and 400-mb surfaces. The ddfff group will be omitted from the report for all standard surfaces above the 200-mb surface.

As both code figures 1 and 2 represent two standard isobaric surfaces in PART A, the following special coding procedures are required:

1. Code figure 1—When the 150-mb surface is included in the report but the 100-mb surface is not included because of termination of the ascent, code figure 1 applies only to the 150-mb surface. When the 100 mb is included in the report but wind data are available only up to and including the 150-mb surface, the wind group will be included for both the 150- and 100-mb surfaces with solidi (/////) being coded for the 100-mb ddfff group.
2. Code figure 2—When the 250-mb surface is included in the report but the 200-mb surface is not included because of termination of the ascent, code figure 2 applies only to the 250-mb

surface. When wind data are available only up to and including the 250-mb surface and the 200-mb surface is included in the report, the wind group will be included for both the 250- and 200-mb surfaces with solidi (/////) being coded for the 200-mb ddfff group.

IIiii identifies the index number II as the block number, and iii is the station number. For example: Adak, Alaska would encode the index number as 70454. Refer to AIR WEATHER SERVICE PAMPHLET 52 for a complete listing of the weather station index.

99 indicator figures identify that a shipboard position groups follow.

NOTE: The ships position (latitude/longitude) will be obtained from the bridge quartermaster or officer of the deck. The position will be given to you in whole degrees and minutes. For example: 38 degrees 39 minutes North latitude and 93 degrees 25 minutes West latitude.

$L_aL_aL_a$ reports the ship's latitude position in tens, units, and tenths of degrees.

The tenths of degrees are obtained by dividing the number of minutes by 6, disregarding the remainder.

For example: 38 degrees 39 minutes North would be encoded as 99386.

U_{La} reports the units figure of the latitude. For example: a latitude of 38°39′N would be encoded as 8.

Q_c indicates the quadrant of the globe.

For this purpose the earth is divided into four quadrants by the Greenwich meridian, the equator, and the 180th meridian (shown in figure 3-8-6).

There are two cases which raise a question regarding the code figure to be reported for symbol Q_c. A procedure has not been established, nor does one seem necessary, to cover these two cases. These two cases occur:

1. When the ship is precisely on the Greenwich meridian (i.e., $L_oL_oL_oL_o$ = 0000) or the 180th meridian (i.e., $L_oL_oL_oL_o$ = 1800) either

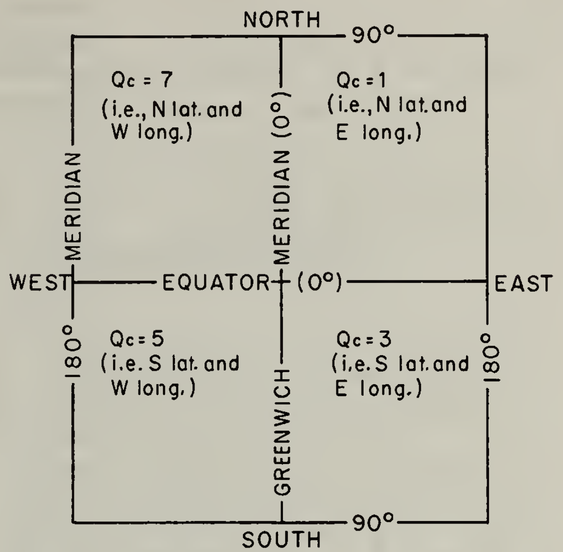

Figure 3-8-6.—Quadrant of the globe.

code figure 1 or 7 (Northern Hemisphere) or code figure 3 or 5 (Southern Hemisphere) may be reported, as appropriate with respect to latitude.

2. When the ship is precisely on the Equator (i.e., $L_aL_aL_a$ = 000), either code figures 1 or 3 (Eastern Hemisphere) or code figures 5 or 7 (Western Hemisphere) may be reported, as appropriate with respect to longitude.

$L_oL_oL_oL_o$ reports the ships longitude position in hundreds, tens, units, and tenths of degrees.

The tenths of a degree are obtained in the same manner as the latitude.

For example: 63 degrees 25 minutes West would be encoded as 0634.

U_{Lo} reports the units figure of the longitude. For example: a longitude of 63°25′W would be encoded as 3.

MMM identifies and verifies the ship's position at the time of the observation by the use of a Marsden square number (shown in appendix III).

Three numbers will be reported for MMM, therefore, a zero will be used for the hundreds and tens digits when required.

MMM is determined by values reported for Q_c, $L_aL_aL_a$, $L_oL_oL_oL_o$, U_{La}, and U_{Lo}. These

Annex to Code Table 104

[Annex to WMO Code Table 2590]

Subdivision of the Marsden ten-degree squares into one-degree subsquares for the four quadrants (Symbol Q_o) of the Globe.

Grid A

Symbol Q_o = Code Figure 7
(0° to 180°W) in
the Northern Hemisphere

99	98	97	96	95	94	93	92	91	90
89	88							81	80
79		77					72		70
69			66			63			60
59				55	54				50
49				45	44				40
39			36			33			30
29		27					22		20
19	18							11	10
09	08	07	06	05	04	03	02	01	00

North Latitude: 10° 9° 8° 7° 6° 5° 4° 3° 2° 1° 0° (top to bottom)

10° 9° 8° 7° 6° 5° 4° 3° 2° 1° 0°
West Longitude

Grid B

Symbol Q_o = Code Figure 1
(0° to 180°E) in
the Northern Hemisphere

90	91	92	93	94	95	96	97	98	99
80	81							88	89
70		72					77		79
60			63			66			69
50				54	55				59
40				44	45				49
30			33			36			39
20		22					27		29
10	11							18	19
00	01	02	03	04	05	06	07	08	09

North Latitude: 10° 9° 8° 7° 6° 5° 4° 3° 2° 1° 0° (top to bottom)

0° 1° 2° 3° 4° 5° 6° 7° 8° 9° 10°
East Longitude

Grid C

Symbol Q_o = Code Figure 5
(0° to 180°W) in
the Southern Hemisphere

10° 9° 8° 7° 6° 5° 4° 3° 2° 1° 0°

09	08	07	06	05	04	03	02	01	00
19	18							11	10
29		27					22		20
39			36			33			30
49				45	44				40
59				55	54				50
69			66			63			60
79		77					72		70
89	88							81	80
99	98	97	96	95	94	93	92	91	90

South Latitude: 0° 1° 2° 3° 4° 5° 6° 7° 8° 9° 10° (top to bottom)

West Longitude

Grid D

Symbol Q_o = Code Figure 3
(0° to 180°E) in
the Southern Hemisphere

0° 1° 2° 3° 4° 5° 6° 7° 8° 9° 10°

00	01	02	03	04	05	06	07	08	09
10	11							18	19
20		22					27		29
30			33			36			39
40				44	45				49
50				54	55				59
60			63			66			69
70		72					77		79
80	81							88	89
90	91	92	93	94	95	96	97	98	99

South Latitude: 0° 1° 2° 3° 4° 5° 6° 7° 8° 9° 10° (top to bottom)

East Longitude

209.484

Figure 3-8-7.—Annex to Marsden square appendix III.

are to be reported by the $MMMU_{La}U_{Lo}$ group. These values are applied to appendix III and its annex (shown in figure 3-8-7) in obtaining the correct Marsden square number to be reported.

Looking at figure 3-8-7, you can see that it consists of four geographic grids. These grids show the breakdown of a 10 degree Marsden square into one-degree subsquares and the number assigned to each of these subsquares.

As the focal point of the Marsden square system 0 degree latitude and 0 degree longitude (i.e., the intersection of the Equator and the Greenwich meridian), four subsquare grids are required to provide for determining the correct Marsden square number in each of the four quarters of the globe. It will be noted that each grid covers one of the code figures specified for Q_c. The value reported for Q_c determines the grid to be used. The value reported for $U_{La}U_{Lo}$ is the number of a one-degree subsquare in the 10 degree Marsden square reported for MMM.

PROCEDURES FOR DETERMINING THE MARSDEN SQUARE NUMBER.—When the value for $U_{La}U_{Lo}$ does not contain a zero, the Marsden square number reported for Symbol MMM is obtained from appendix III without reference to its Annex. For example: A latitude of 38°39′N and a longitude of 63°25′W would indicate a Marsden square number of 115.

When one of the digits of the value for $U_{La}U_{Lo}$ is a zero, the ship is on the boundary between two Marsden squares. In this case the Marsden square whose one-degree subsquare number corresponds to the $U_{La}U_{Lo}$ value is reported for MMM. For example: Assuming a position of N 10.0° and E 154.4° (i.e., $Q_c = 1$, $L_aL_aL_a = 100$, $L_oL_oL_oL_o = 1544$ and $U_{La}U_{Lo} = 04$), the position is on the boundary line between Marsden square 21 and 57 as the $U_{La}U_{Lo}$ value contains a zero. When grid B is superimposed on Marsden squares 57 and 21, subsquare 04 of square 57 and subsquare 94 of square 21 contact the position. As the $U_{La}U_{Lo}$ value is the number of the one-degree subsquare, only the Marsden square whose one-degree subsquare number corresponds to the $U_{La}U_{Lo}$ value is the correct Marsden square number. In this case Marsden square number 57 has the corresponding subsquare number of 04; therefore, the $MMMU_{La}U_{Lo}$ group is coded 05704.

When both of the digits of the $U_{La}U_{Lo}$ value are zero (i.e., $U_{La}U_{Lo} = 00$), the ship is always at the point of contact of four Marsden squares. In this case the Marsden square number whose one-degree subsquare number is 00 is reported for MMM. For example: Assuming the ship's position to be S 40.0° and W 20.0° (i.e., $Q_c = 5$, $L_aL_aL_a = 400$, $L_oL_oL_oL_o = 0200$, and $U_{La}U_{Lo} = 00$), the ship is located at the point of contact of the four Marsden squares numbered 409, 410, 445, and 446. When grid C is superimposed on each of these Marsden squares, subsquare numbered 00 in square 446, subsquare 09 in square 445, subsquare 99 in square 409, and subsquare 90 in square 410 are at the point of contact of these four squares. As the $U_{La}U_{Lo}$ value is the number of the required one-degree subsquare, only the Marsden square whose one-degree subsquare number corresponds to the $U_{La}U_{Lo}$ value is the correct Marsden square number. In this case only Marsden square 446 has the corresponding subsquare number of 00; therefore, the $MMMU_{La}U_{Lo}$ group is coded 44600.

There are two geographic points where the instructions are given when the digits of U_{La} and U_{Lo} are both zero, preceding, do not apply, with these points being at the Equator and the Greenwich meridian (i.e., 0 degree latitude and 0 degree longitude) and at the Equator and the 180th meridian (i.e., 0 degree latitude and 180 degree longitude). The Marsden squares surrounding the Equator and Greenwich intersections are 1, 36, 300, and 335. When the appropriate grid is superimposed on each of these four squares, it will be noted that all four of the grids are involved and that only the subsquares numbered 00 contact the point. The same situation exists at the Equator and the 180th meridian and involves Marsden squares 18, 19, 317, and 318 with subsquare 09 in each grid contacting the point. In both of these cases, Q_c will be used in determining the appropriate Marsden square number to be reported. The value to be reported for Q_c will be determined to the smallest increment available of the latitude and longitude of the ship's position.

EXERCISE (3-8-1)

Match the correct definition with each term. Enter the letter of the definition on the line preceding the term.

Term

1. ________UUBB
2. ________YY
3. ________GG
4. ________I_d
5. ________IIiii
6. ________$L_aL_aL_a$
7. ________$L_oL_oL_oL_o$
8. ________Q_c
9. ________MMM
10. ________$U_{La}U_{Lo}$

Definition

a. Longitude

b. Last standard isobaric surface for which ddfff is reported in PART A

c. Marsden square number

d. An upper air report from a shipboard station with information about significant levels

e. Quadrant of the globe

f. Day of the month

g. Units figure

h. Block and land station number

i. Time of observation

j. Latitude

Standard Isobaric Surfaces (Section 2)

Section 2 (PART A) contains data for the Surface Level and the Standard Isobaric Surfaces (Mandatory Levels) from the surface up to and including the 100-mb level.

$99P_oP_oP_o$ $T_oT_oT_{ao}D_oD_o$ $d_od_of_of_of_o$ (Surface data)

All three groups of the surface data will be included in Section 2 of PART A.

NOTE: For coding purposes, the Surface Level is considered to be both a mandatory level and a significant level. Therefore, data for the surface level will be reported in the standard isobaric surface form in Section 2 in PART A and in the significant level form in Section 5 in PART B.

$\left.\begin{array}{c}00\\ \text{To}\\ 10\end{array}\right\}$ **hhh TTT_aDD ddfff** (mandatory levels)

Data for the standard isobaric surfaces consists of the surface indicator, geopotential height, temperature, and dew point depression will always be reported for all of the standard isobaric surfaces included in the report. Solidi will be coded to indicate data are missing when required. The wind group will be included in, or omitted from, the report as specified by the value reported for symbol I_d (shown in figure 3-8-5).

Section 2 of PART A mandatory levels are: 1000-, 850-, 700-, 500-, 400-, 300-, 250-, 200-, 150-, and 100-mb levels. For PART C they are 70-, 50-, 30-, 20-, 10-, 7-, 5-, 3-, 2-, and 1-mb levels.

When the geopotential of one (or more) of the standard isobaric surfaces is lower than the altitude of the station, the first two data groups (e.g., 00hhh TTT_aDD) for that surface will be included in the report with solidi being reported for the TTT_aDD group. The wind groups (i.e., ddfff) for those surfaces will be included in, or omitted from, the report as specified by the value reported for symbol I_d. In the event the ddfff groups are included for those surfaces for which data are not available, five solidi (/////) will be coded for those groups.

When a standard isobaric surface and a significant level (with respect to air temperature and/or relative humidity) coincide, data for that level will be reported as both a standard isobaric surface in Section 2 and a significant level in Section 5.

Definitions of the symbolic letters or numbers for Section 2 are:

99 indicator identifies the surface data in Section 2 of the land station or shipboard station follows.

$\mathbf{P_oP_oP_o}$ is used to report the surface pressure in whole millibars. For example: A surface pressure of 1014.4 mb would be entered as 99014. When the pressure value becomes doubtful, as classified in the FMH-3, the ascent is terminated; hence, there is no requirement for indicating missing pressure values in the coded report.

$\mathbf{T_oT_o}$ is used to report the surface temperature in whole degrees Celsius. The actual temperature as observed will be reported (i.e., it is not rounded off before coding). The reportable values will be inserted in the positions specified in Sections 2, 3, and 5, as appropriate, of both the land and shipboard forms of messages.

Two code figures are required for temperature. Hence, temperatures from 0° to 9°, inclusive, shall be coded 00, 01, 02, etc.

When the temperature is missing or unknown, solidi (//) will be reported.

When an observed temperature value is classified as doubtful, it will be coded in the usual manner and indicated as being doubtful by means of the Additional Data groups in Section 9.

NOTE: Temperatures shall be classified as doubtful by following the criteria given in the FMH-3.

$\mathbf{T_{ao}}$ is used to report the approximate tenths value and the sign (i.e., plus or minus) of the surface air temperature in Section 2 and Section 5. Use code table 106 as seen in figure 3-8-8 for the reportable value.

It will be noted that Code Table 106 provides for reporting temperatures to the nearest two-tenths of a degree. In addition it provides for indicating if the temperature is above zero or below zero degrees. When the code figure reported for T_a is even (i.e., 0, 2, 4, 6, or 8), the temperature is above zero. When the code figure is uneven (i.e., 1, 3, 5, 7, 9) the temperature is below zero. Also each code figure represents two-tenths of a degree. For example: Code figure 0 represents a positive temperature with the

Code Table 106

[WMO Code 3931]

Code figure	Sign of temperature*	Temperature (tenths)
0	+	0.0° and 0.1°
1	−	0.0° and 0.1°
2	+	0.2° and 0.3°
3	−	0.2° and 0.3°
4	+	0.4° and 0.5°
5	−	0.4° and 0.5°
6	+	0.6° and 0.7°
7	−	0.6° and 0.7°
8	+	0.8° and 0.9°
9	−	0.8° and 0.9°

Figure 3-8-8.—Code figure for approximate tenths value and the sign (+ or −).

tenths value being either 0.0° or 0.1 °C. Code figure 1 represents a minus temperature with the tenths value being either 0.0° or 0.1 °C; code figure 2 represents +0.2° or +0.3°; code figure 3 represents −0.2° or −0.3°; etc.

When the temperature is missing or unknown, a solidus (/) will be reported.

D_oD_o is used to report the depression of the surface dew point temperature in Section 2 and Section 5.

The depression of the dew point temperature (with respect to water) in degrees Celsius will be reported for D_oD_o symbols according to the specifications of Code Table 102 (shown in figure 3-8-9). The reportable values will be inserted in the positions specified in Sections 2 and 5, as appropriate, of both the land and shipboard forms of messages.

The depression of the dew point temperature is determined to tenths of a degree (i.e., both the air temperature and the dew point temperature are determined to tenths of a degree before the subtraction is made to obtain the depression).

It will be noted that Code Table 102 is arranged so that it is practically direct reading in that code figures 00 to 49, inclusive, represent the units and tenths digits of the depression; i.e., they represent 0.0° to 4.9° inclusive. Code figures 56 to 99, inclusive, represent the tens and units digits of the depression plus 50; i.e., if 50 is subtracted from the code figure, the remainder is the depression in whole degrees Celsius.

NOTE: Depressions of 6° to 49°, inclusive, are coded to the nearest whole degree. Code figure 50 represents a depression of 5.0° to 5.4°, inclusive.

When the five-figure data group containing air temperature and depression of the dew point for a particular level must be included in the message and humidity data are not available for that level, two solidi (//) will be reported for the dew point depression to indicate the data is missing.

When the air temperature at a specified or selected upper level is classified as doubtful, the depression of the dew point at that level will be classified as doubtful also.

Code Table 102

[WMO Code 0777]

Code figure	Depression of the dew point in degrees Celsius	Code figure	Depression of the dew point in degrees Celsius
00	0.0	40	4.0
01	0.1	41	4.1
02	0.2	42	4.2
03	0.3	43	4.3
04	0.4	44	4.4
05	0.5	45	4.5
06	0.6	46	4.6
07	0.7	47	4.7
08	0.8	48	4.8
09	0.9	49	4.9
10	1.0	50	5
11	1.1	51	
12	1.2	52	
13	1.3	53	Not used
14	1.4	54	
15	1.5	55	
16	1.6	56	6
17	1.7	57	7
18	1.8	58	8
19	1.9	59	9
20	2.0	60	10
21	2.1	61	11
22	2.2	—	—
23	2.3	70	20
24	2.4	71	21
25	2.5	—	—
26	2.6	80	30
27	2.7	81	31
28	2.8	—	—
29	2.9	89	39
30	3.0	90	40
31	3.1	91	41
32	3.2	—	—
33	3.3	98	48
34	3.4	99	49 or more
35	3.5		
36	3.6		
37	3.7		
38	3.8		
39	3.9		

Figure 3-8-9.—Dew point depression code figure.

Dew point temperatures are not evaluated at air temperatures below −40°C; hence, two solidi (//) will be coded.

$d_od_of_of_of_o$ reports the wind direction and speed for the surface. The surface wind group will be included in the report. Therefore, if the wind data is missing, solidi (/////) will be reported for the wind group.

d_od_o is used to report the surface true wind direction in tens of degrees (i.e., the hundreds and tens digits are rounded off to the nearest 5 degrees) from which the surface wind is blowing.

The wind direction will be coded to the nearest 5 degree, which requires the use of the entire five-figure wind group (i.e., both the direction and the speed). The observed wind direction is rounded off to the nearest 5 degree before coding (e.g., 293 degree is rounded to 295 degree before coding; 292 degree is rounded to 290 degree before coding). The wind direction will be coded in two steps as follows:

- The hundreds and tens digits of the rounded direction will be coded for d_od_o.

- The rounded units digit of the direction (i.e., 0 degree or 5 degree) will be added to the hundreds digit of the wind speed (i.e., fff) and the sum will be coded for fff. A second way of stating the rule is: When the rounded direction units digit is 5 degree, 500 is added to the wind speed, and the wind and the sum is coded for fff. When the rounded direction units digit is 0 degree, the wind speed is coded directly for fff without change. For example: If the rounded wind direction is 295 degree and the speed is 162 knots, dd is coded 29 and fff is coded 662 (162 + 500 = 662). If the rounded direction is 290 degree and the speed is 162 knots, dd is coded 29 and fff is coded 162 (i.e., 162 + 0 = 162).

When a calm exists (i.e., the speed is zero), code figure 00 will be coded for the direction.

When the direction is missing for a specified level whose wind group must be included in the report, solidi (//) will be coded for the direction.

$f_of_of_o$ indicates the wind speed of the surface in knots, or in knots plus 500.

The observed wind speed will be either coded directly for $f_of_of_o$ or modified by the addition of 500 to indicate that 5 degree is to be added to the value of the wind direction reported for dd.

When a calm exists (i.e., the speed is zero), code figure 000 will be coded for the speed.

When the speed is missing for a specified level whose wind group must be included in the report, solidi (///) will be coded for the speed.

00 to 10 are number indicators used to report the hundreds and tens digits of the millibar value of the mandatory level. For PART A the 1000-, 850-, 700-, 500-, 400-, 300-, 250-, 200-, 150-, and 100-mb mandatory levels are identified by the indicator figures 00, 85, 70, 50, 40, 30, 25, 20, 15, and 10, respectively.

For PART C the 70-, 50-, 30-, 20-, 10-, 7-, 5-, 2-, and 1-mb mandatory levels are identified by the indicator figures 70, 50, 30, 20, 10, 07, 05, 03, 02, and 01, respectively.

Examples of the use of the indicator figures are: In PART A, data for the 500-mb surface are given in the form 50hhh TTT_aDD ddfff where 50 is the indicator figure for the standard surface of 500 mb. In PART C, data for the 50-mb surface are given in the form 50hhh TTT_aDD ddfff where 50 is the indicator figure for the 50-mb surface. Data for the 5-mb surface are given in the form 05hhh TTT_aDD ddfff where 05 is the indicator for the 5-mb surface height of the specified standard for the 5-mb surface.

The heights will be reported in increments of meters as follows:

- Geopotential heights are reported in whole geopotential meters for surfaces up to 500 mb (e.g., 160 gpm is coded 160; 3,249 gpm is coded 249, etc.).

- Geopotential heights are reported in tens of geopotential meters for surfaces at 500 mb and higher (i.e., only the thousands, hundreds, and tens digits of the geopotential height value are reported). For example: 6,053 gpm is coded 605 (i.e., in tens of meters); 11,261 gpm is coded 126; 17,727 gpm, 773, etc.

NOTE: The rule for the disposal of insignificant figures is followed in determining the nearest tens value to be coded for hhh.

The recipient should experience no difficulty in determining the thousands or the tens of thousands figure for the geopotential height as the isobaric surface to which it refers is included in the same group; e.g., 50hhh (where 50 represents 500 mb in PART A). A listing of pressures and their corresponding geopotential heights according to the ICAO standard atmosphere is given in Code Table 107 (shown in figure 3-8-10).

Geopotential heights below mean sea level will be coded by adding 500 to the actual value in meters (disregarding the minus sign) and coding the sum. For example: If the 1000-mb level is 239 meters below mean sea level (i.e., −239 gpm), add 500 to 239 and code the sum (i.e., 739) in the usual manner as 739.

For coding purposes, geopotential height data will be considered doubtful when the corresponding temperature data have been classified as doubtful for limits of strata in excess of those listed in the FM4-3.

NOTE: The pressure of the lower and upper limits of the stratum of doubtful geopotential height data are reported in Section 9 by means of Additional Data groups.

TTT_aDD is used to report the temperature and dew point depression for the mandatory levels from Section 2 and the significant levels from Section 5 as required. The encoding procedures are the same as that of the surface temperature data.

ddfff is used to report the wind direction and speed for the mandatory levels from Section 2. The encoding procedures are the same as that of the surface wind data.

Tropopause Data (Section 3)

$88P_tP_tP_t$ $T_tT_tT_{at}D_tD_t$ $d_td_tf_tf_tf_t$ or 88999

Section 3 consists of the pressure at the level of the tropopause, the temperature, dew point depression, and the direction and speed of the wind.

Code Table 107

Pressure in Millibars	Geopotential Height in	
	Standard[1] Geopotential Feet	Standard[1] Geopotential Meters
1,000	364	111
950	1,773	540
900	3,243	988
850	4,781	1,457
800	6,394	1,949
750	8,091	2,466
700	9,882	3,012
650	11,780	3,591
600	13,801	4,206
550	15,962	4,865
500	18,289	5,574
450	20,812	6,344
400	23,574	7,185
350	26,631	8,117
300	30,065	9,164
250	33,999	10,363
200	38,662	11,784
150	44,647	13,608
100	53,083	16,180
90	55,275	16,848
80	57,726	17,595
70	60,504	18,442
60	63,711	19,419
50	67,507	20,576
40	72,177	22,000
30	78,244	23,849
20	86,881	26,481
10	101,885	31,055

Figure 3-8-10.—Pressure-geopotential height.

When tropopause data are being reported, all three groups of Section 3 will be included in the report. If data for any of the parameters are missing, solidi will be coded for those parameters for which data are missing.

Data for only the first tropopause will be reported when there are more than one during the ascent.

If the tropopause occurs at or below 100 mb, data for it will be reported in Section 3 in

PART A. If the tropopause occurs above 100 mb, data for it will be reported in Section 3 in PART C.

Section 3 will be included in the report when tropopause data are available. If for any reason (and regardless of the geopotential height of the ascent) a tropopause is not observed within the stratum covered by PART A or the stratum covered by PART C, the indicator group 88999 will be reported instead of Section 3 for either or both the PARTS, as appropriate. The 88999 indicator group specifies that a tropopause has not been observed or reported, with respect to the PART in which it appears.

Examples of coding Section 3 are:

1. If a tropopause cannot be determined throughout the entire ascent, the group 88999 is reported instead of Section 3 in both PARTS A and C, provided PART C is reported.
2. If a tropopause is determined at or below 100 mb, the data are reported by means of Section 3 in PART A and the 88999 group is reported in PART C instead of Section 3, provided PART C is reported.
3. If a tropopause is determined above 100 mb, the data are reported by means of Section 3 in PART C, and the 88999 group is reported instead of Section 3 in PART A.

In no instance will the transmission of PART A or PART C be delayed beyond its scheduled transmission time in order to determine or code tropopause data. Therefore, if for any reason tropopause data cannot be included in PART A or PART C, as appropriate, the 88999 group will be reported in lieu of Section 3, and the late tropopause data will be transmitted as soon as practicable in the form of a correction message, covered later in this lesson.

If an ascent terminates less than 2 km above a level which otherwise appears to be a tropopause, that tropopause is classed as being incompletely defined and is not reported. If no other tropopause is determined for the ascent, the group 88999 will be reported. Definitions of the symbolic letters or numbers for Section 3 are:

88 indicator specifies that data at the tropopause level follow. The indicator figures are inserted in Section 3 of PARTS A and/or C, as appropriate, in both the land and shipboard messages.

$\mathbf{P_tP_tP_t}$ is used to report the tropopause pressure in whole millibars for PART A and in tenths of a millibar for PART C.

$\mathbf{T_tT_tT_{at}D_tD_t}$ is used to report the tropopause temperature and dew point depression. The procedure for encoding is the same as the surface data of Section 1.

$\mathbf{d_td_tf_tf_tf_t}$ is used to report the tropopause wind direction and speed. The procedure for encoding is the same as the surface data of Section 1.

88999 is used for any reason a tropopause is not observed, the indicator group 88999 shall be reported in lieu of Section 3 (i.e., it replaces the three data groups of Section 3). The 88999 group gives positive notification to the recipient that a tropopause was not observed in the stratum covered by the PART in which it appears. The 88999 group will be inserted in the position specified for Section 3 in PART A and/or C, as appropriate, in both the land and shipboard forms of messages.

Maximum Wind Data (Section 4)

$$\left.\begin{matrix}\mathbf{77}\\ \text{or}\\ \mathbf{66}\end{matrix}\right\}\quad \mathbf{P_mP_mP_m}\quad \mathbf{d_md_mf_mf_mf_m}\quad \mathbf{4V_bV_bV_aV_a}\quad \text{or}\quad \mathbf{77999}$$

NOTE: This will cover the material needed for encoding the maximum wind data. The procedures for computing winds aloft will be covered in unit 2 lesson 3 of this manual. A level of maximum wind is defined as a level at which the wind speed is greater than that observed immediately above and below that level.

For coding purposes a level of maximum wind must satisfy the following criteria:

- It must occur above the 500-mb level, and it must have a speed greater than 60 knots; and

- It must be determined by consideration of the list of significant points for wind speed.

Levels of maximum wind speed are defined as follows:

Primary Maximum Wind—A primary maximum wind is defined as the greatest wind speed occurring within a PART (i.e., within PART A or PART C).

Secondary Maximum Wind—A secondary maximum wind within a PART is defined as one whose speed exceeds the speeds of the two adjacent minimals by at least 20 knots.

Terminating Level Wind—The terminating level of the sounding will be reported as a level of maximum wind provided.

- The wind speed is greater than 60 knots; and
- It constitutes the greatest speed of the entire sounding.

The three data groups of Section 3 will be reported when a maximum wind is determined for inclusion in PART A or C.

NOTE: The three data groups of Section 4 are reported if a primary or secondary maximum wind or a terminating level wind is being reported.

If a maximum wind occurs at or below 100 mb, it will be included in PART A. If a maximum wind occurs above 100 mb, it will be included in PART C. Therefore, if for any reason an observed maximum wind cannot be included in PART A or PART C, as appropriate, the maximum wind will be transmitted later in the form of a correction message (i.e., according to the procedures given later in this lesson). In no instance will the transmission of PART A or PART C be delayed beyond its collection transmission time in order to determine or code maximum wind data.

Data for not more than two maximum winds will be reported in a PART. These maxima will consist of the primary maximum and a secondary maximum for that PART. The primary maximum will appear first in the message followed immediately by the secondary maximum. The secondary maximum will be coded by repeating Section 4.

NOTE: When reduction of the primary maximum wind data results in two peaks of equal speed at different levels within a PART and neither peak qualifies as a secondary maximum wind, the one at the greatest altitude will be reported as the primary maximum wind. In this case the speed at the lower altitude will not be reported.

If more than one secondary maximum wind of the same speed occurs that is suitable for inclusion in a PART, the one at the greater altitude will be included.

When the wind at the terminating level of the sounding qualifies for reporting as a level of maximum wind, it will be coded by means of Section 4, and it will appear first in the message. The terminating level wind will be followed immediately by a secondary maximum, if one is observed.

NOTE: The definition of the primary maximum wind specifies that it is the greatest speed occurring within a PART. However, we are dealing with two strata (i.e., the first stratum covers up to and including 100 mb and the second stratum covers above 100 mb) in determining and reporting maximum winds; therefore, each PART (i.e., A and C) could have a primary and a secondary maximum.

When the ascent goes above 500 mb and a level of maximum wind is not observed within the stratum covered by PART A or the stratum covered by PART C, the group 77999 will be reported for either or both PARTS, as appropriate. The 77999 indicator group specifies that a maximum wind was not observed with respect to the PART in which it appears.

When the ascent does not reach 500 mb, both Section 4 and the 77999 group will be omitted from the report.

Examples of coding Section 4 and the group 77999 when the ascent goes above 500 mb are:

- If a maximum wind is not observed throughout the ascent, the group 77999 will be reported instead of Section 4 in both PARTS A and C, provided PART C is reported.

- If the only maximum wind observed throughout the ascent occurs at or below 100 mb,

the data will be reported by means of Section 4 in PART A, and the 77999 group will be reported instead of Section 4 in PART C, provided PART C is reported.

- If the only maximum wind observed throughout the ascent occurs above 100 mb, the data will be reported by means of Section 4 in PART C, and the 77999 group will be reported instead of Section 4 in PART A.

77 is used when:

- the maximum wind occurred within the sounding;
- the maximum wind criteria are satisfied; and
- the location, with respect to altitude, of the level of maximum wind was determined by means of pressure.

Therefore, the groups $77P_mP_mP_m$ $d_md_mf_mf_mf_m$ will be used to report the maximum wind data obtained under the above conditions.

66 is used when:

- the greatest wind speed observed throughout the sounding occurred at the terminating level of the sounding;
- its speed is greater than 60 knots; and
- the location, with respect to altitude, of the level of the maximum wind was determined by means of pressure.

Therefore, the groups $66P_mP_mP_m$ $d_md_mf_mf_mf_m$ will be used to report the maximum wind data obtained under the above conditions.

$\mathbf{P_mP_mP_m}$ is used to report the pressure at the level of maximum wind. In PART A the pressure is reported to the nearest whole millibar. In PART C the pressure is reported to tenths of a millibar.

4 is used in Section 4 to specify vertical wind shear follows.

NOTE: The procedure for computing vertical wind shear can be found in FMH-5 or in unit 2 lesson 3 of this manual.

$\mathbf{V_bV_b}$ is used to report the absolute value of the vector difference between the maximum wind and the wind blowing at 3,000 feet below the level of the maximum wind.

$\mathbf{V_aV_a}$ is used to report the absolute value of the vector difference between the maximum wind and the wind blowing 3,000 feet above the level of maximum wind

The absolute value of the vector difference is reported to the nearest whole knot. When Section 4 is included in the report and the vector difference cannot be obtained, solidi (//) will be reported for V_aV_a or V_bV_b to indicate the datum is missing. When the vector difference is 99 knots or more, code figure 99 will be reported. The reportable value is inserted in the position specified in Section 4 in PARTS A and/or C, as appropriate, in both the land and shipboard forms of messages.

EXERCISE (3-8-2)

Match the correct definition with each term. Enter the letter of the definition on the line preceding the term.

Term	Definition
1. ________99	a. 350-mb height
2. ________$P_oP_oP_o$	b. Surface pressure
3. ________$T_oT_oT_{ao}$	c. Maximum wind not observed
4. ________D_oD_o	d. Surface depression
5. ________85hhh	e. Maximum wind found at termination level of sounding
6. ________88	f. Vertical shear data follows
7. ________D_tD_t	g. Maximum wind found within sounding
8. ________88999	h. Tropopause not observed
9. ________77	i. Surface temperature
10. ________66	j. Tropopause data follows
11. ________4	k. Surface data follows
12. ________77999	l. Tropopause depression

Significant Levels (Section 5)

$$\left.\begin{array}{c}\mathbf{00}\\ \text{To}\\ \text{etc.}\end{array}\right\} \quad \text{PPP TTT}_a\text{DD}$$

Section 5 contains data for the surface level and significant levels with respect to temperature and/or relative humidity. The data consists of the pressure, temperature, and the depression of the dew point.

NOTE: The procedures for selecting significant level can be found in FMH 3 and 4 and also in Unit 2 Lesson 2 of this manual.

A sufficient number of levels should be included so that a linear interpolation between any two consecutively transmitted significant levels gives a close approximation to the observed data.

00 indicator number is reserved as the identifier for the surface data group and will be used to identify any other significant level.

The significant level indicator numbers are used to identify the significant levels which are determined with respect to temperature and/or relative humidity. The significant levels will be numbered in consecutive order (i.e., lowest to highest with respect to geopotential height). The

indicator numbers will be inserted in the positions specified in Section 5 in PARTS B and D, as appropriate, in both the land and sea forms of messages.

A double number is used as the indicator number. For example: The 1st level is coded 11; 2d level 22; 3d level 33; etc.; 9th level, 99; 10th level, 11; 11th level, 22; 12th level, 33; etc.

The indicator numbers will be consecutive in Section 5 only for the PART in which they appear. They are not consecutive for the entire sounding. For example: In PART B the successive significant levels are numbered 00 (surface), the first level 11, 22,...etc....99, 11, 22, etc. In PART D the first significant level is numbered 11, the second 22,...etc....99, 11, 22, etc.

When a stratum of missing data occurs and observed data are available below and above the missing stratum, a set of data groups is inserted in the message in normal sequence to represent the missing stratum. The groups representing the missing stratum are coded by means of the appropriate level indicator number and solidi. The levels bounding the missing stratum will be reported also. For this purpose the boundary levels are defined as the levels that are closest to the bottom and top of the missing stratum and for which reportable data are available.

The boundary levels and missing stratum groups will be identified by appropriate level indicator numbers. For example: If a missing stratum occurs following the second significant level, the coding of that portion of PART B (or D) would be...... ......

22PPP	TTT_aDD
33PPP	TTT_aDD
44///	/////
55PPP	TTT_aDD
66PPP	TTT_aDD

Where—Indicator numbers 22 and 66 identify significant levels determined by means of the significant level criteria. Indicator numbers 33 and 55 identify the boundary levels. Indicator number 44 identifies the missing stratum.

In the event the stratum for which data are missing bridges the 100-mb level, special coding arrangements are required to comply with the regulation that only data up to and including the 100-mb level will be included in PART B, and only data above 100 mb will be included in PART D. In this case, only the lower boundary level and the solidi for the missing level will be included in PART B, and solidi for the missing level and the upper boundary level will be included in PART D. For example: If the lower boundary level of the missing stratum occurs at 105 mb and the upper boundary level occurs at 80 mb, the coding in PART B would be 77105 TTT_aDD 88/// ///// (assuming the lower boundary level number is 77), and in PART D the coding would be 11/// ///// 22800 TTT_aDD 33PPP TTT_aDD, etc.

Regional and Additional Data (Section 9)

51515 101 A_{df} A_{df}

The indicator group 51515 identifies Section 9 which contains regionally developed code forms. In this case the region refers to WMO Region IV which consists of North and Central America. The only code forms adopted by Region IV for reporting radiosonde data are the Additional Data groups ($A_{df}A_{df}$) according to the specifications given in Code Table 101. These Additional Data groups are usually referred to as the 101-groups (101 $A_{df}A_{df}$). The indicator group 51515 is inserted in the position specified in Section 9 in PARTS B and/or D, as appropriate, in both the land and sea forms of messages when Additional Data are reported.

The Additional Data group indicator 101 identifies the $101A_{df}A_{df}$ group has been adopted by WMO Region IV (i.e., North and Central America) to report additional information not otherwise provided for in the coded message. When reported, the $101A_{df}A_{df}$ groups are inserted in the position specified in Section 9 in PARTS B and/or D, as appropriate, in both the land and sea forms of messages.

The Additional Data shall be reported according to the specifications given in Code

Code Table 101
[WMO Code 421]

Code figure	Specification
00	Not to be assigned.
	01–31: Unassigned
	32–39: Not to be assigned
	40–59: Reason for No report or Incomplete Report
40	Report not filed.
41	
42	Ground equipment failure.
43	Observation delayed.
44	Power failure.
45	Unfavorable weather conditions.
46	Low maximum altitude (less than 500 meters above ground).
47	Leaking balloon.
48	Ascent not authorized for this period.
49	Alert.
50	Ascent did not extend above the 100–mb level.
51	Balloon forced down by icing condition.
52	Balloon forced down by precipitation.
53	Atmospheric interference.
54	Local interference.
55	Fading signal.[1]
56	Weak signal.[1]
57	Preventive maintenance.
58	Flight equipment (transmitter, balloon, attachments, etc.) failure.
59	Any reason not listed above.
	60–64: Miscellaneous
60	
61	Aerometeorograph report precedes.
62	Radiosonde report precedes.
63	
64	
	65–69: Doubtful and Missing Data
65	Altitude and temperature data are doubtful between following levels ..... $0P_1P_1P_2P_2$.
66	Altitude levels are doubtful between following levels ..... $0P_1P_1P_2P_2$.
67	Temperature data are doubtful between following levels .....$0P_1P_1P_2P_2$.
68	Depression of the Dew Point is Missing Between Following Levels ..... $0P_1P_1P_2P_2$.
69	Depression of the Dew Point is Missing at the Following Levels ..... PPhhh PPhhh (or nnPPP etc, as appropriate). (Not used when TT is also missing.)

Code Table 101—Continued

Code figure	Specifications
	70–74: Unassigned
70	
71	
72	
73	
74	
	75–89: Corrected Data
75	
76	
77	
78	Corrected Tropopause Data (Section 3) follows.
79	Corrected Maximum Wind (Section 4) follows.
80	Corrected entire report (PARTs A, B, C and D) precedes.
81	Corrected report for PARTs A and B precedes.
82	Corrected report for PARTs C and D precedes.
83	Corrected data for Mandatory Levels follow.
84	Corrected data for Significant Levels follow.
85	Minor error(s) in this report, correction follows.
86	Significant level(s) not included in original report follows.
87	Corrected data for surface follow.
88	Corrected Additional Data groups follow ..... $101A_{df}A_{df}$ ..... etc.
89	
	90–93: Miscellaneous
90	Extrapolated altitude data follow .....PPhhh.
91	Extrapolated surface data precedes.
92	
93	
	94–99: Early Transmission Messages
94	Low-Level Mean Winds for Surface to 5,000-foot Layer and 5,000- to 10,000-foot Layer ..... ddfff ddfff
95	Early transmission of 850– and 500–mb data and stability index follow ..... 85hhh TTT_aDD ddfff 50hhh TTT_aDD ddfff i_si_s.
96	Early transmission of 850–, 700–, and 500–mb data and stability index follow .....85hhh TTT_aDD ddfff 70hhh TTT_aDD ddfff 50hhh TTT_aDD ddfff i_si_s.
97	Early transmission of 500–mb data stability index follow ..... 50hhh TTT_aDD ddfff i_si_s.
98	Early transmission of 700–mb data and stability index follow ..... 70hhh TTT_aDD ddfff i_si_s.
99	Not to be assigned.

[1] Fading signals differ from weak signals in that "fading signals" are first received satisfactorily, then become increasingly weaker, and finally become too weak for reception, while "weak signals" are weak from the beginning of the ascent.

Figure 3-8-11.—Additional data code figures.

Table 101 (shown in figure 3-8-11) for symbol $A_{df}A_{df}$. For a complete breakdown of the additional data code figures, refer to FMH-4.

Message Separation Signal

The message separation signal will be inserted in the message as indicated in the symbolic forms of messages to mark the termination of a particular portion of the report. The separation signal is always added, without a space intervening, to the last data group of that portion of the report so that in most instances the last group will become a six-figure group.

The separation signal will be added at the end of PARTS A, B, C, and D of both the land and sea forms of messages. It is also added at the end of all other types of messages containing observed radiosonde data as specified; e.g., messages containing corrective data, missing data, etc.

The message separation signal was devised for use in connection with the automatic processing of data by electronic equipment in both meteorological and telecommunications operations. Therefore, the inclusion of the message separation signal in the report in its correct position is essential to the efficient operation of that equipment.

EXERCISE (3-8-3)

Match the correct definition with each term. Enter the letter of the definition on the line preceding the term.

Term	Definition
1. ________00PPP	a. Regional additional codes follows
2. ________55PPP	b. Additional data group
3. ________77///	c. Significant level pressure missing
4. ________51515	d. Pressure data for level number 5
5. ________101	e. Pressure data for surface level

CORRECTIONS

When it is necessary to delay transmission of a Radiosonde Report which is known to be in error, or to correct a Report that has been transmitted, the procedures given in this lesson will be followed.

Correcting Before Transmission

If it is discovered that major errors exist in the coded report and there is insufficient time to correct them before the scheduled time of transmission or the observation is in progress but has not been completed, an Observation Delayed message will be sent in lieu of the report. This Observation Delayed message will consist of an Additional Data group in Section 9 in PART B. On Service C the form of message for a land station is: IIiii TTBB YYGG/ IIiii 51515 10143 Ⓓ. The form of message for a shipboard station is: UUBB YYGG/ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ 51515 10143 Ⓓ. The corrected report will be filed for transmission as a late report as soon as practicable.

If minor errors are discovered in the coded report prior to filing for transmission and there is insufficient time to correct them, the

Additional Data group 10185 will be included in Section 9 of PARTS B and/or D, as appropriate. This group (10185) means minor errors are present in the report and an appropriate correction message will follow.

Major and minor errors are roughly defined as follows: Major errors are those which invalidate the report; minor errors are those which can be readily detected after the sounding is plotted.

Correcting Entire Report After Transmission

If the entire report (i.e., PARTS A, B, C, and D) is sent as a single message and there are numerous errors in it, the least confusing and more efficient procedure may be to correct the entire Report rather than to correct certain groups. The additional data group 10180 (meaning correction for entire report) will be included in Section 9 of PARTS B and D of the corrected message.

The corrected report will be filed for transmission as soon as possible.

Correcting Transmitted Mandatory Level Data

When it is necessary to correct an element of a mandatory level (i.e., a standard isobaric surface), the three groups for the level in question will be included in the correction message. The inclusion of the wind group (ddfff) is compulsory in this instance regardless of the coding of symbol I_d in the original message. When wind data are missing, solidi will be coded for the group. With this procedure there will be no confusion regarding the level being corrected or the corrected data because (1) the levels are self-identifying and (2) the data given for the element in the correction message will be different from that sent in the original message.

The additional data group 10183 will be used to indicate corrected data for mandatory levels will follow. This information will be reported in Section 9 of PARTS B and/or D, as appropriate.

A correction message may apply to one or more mandatory levels, as required, and it will be transmitted as soon as practicable.

For example: If data for the 700-mb level are being corrected, the message for a land station on Service C has the form: IIiii TTBB YYGG/ IIiii 51515 10183 70hhh TTT_aDD ddfff ⏀.

Similarly, if corrective data for the 700- and 500-mb standard isobaric surfaces are being sent, the message from a land station on Service C will have the following form: IIiii TTBB YYGG/ IIiii 51515 10183 70hhh TTT_aDD ddfff 50hhh TTT_aDD ddfff ⏀.

Correcting Transmitted Significant Level Data

In correcting an element of a significant level, two groups (i.e., nnPPP TTT_aDD) for the level in question will be included in the Correction message. There should be no confusion regarding the level being corrected or the corrected data because the levels are numbered and the pressure of the level is given. Also, it should be obvious as to which element(s) is to be corrected as the corrected data will be different from those sent in the original message.

A correction message may apply to one or more significant levels, as required, and it will be transmitted as soon as practicable.

The Additional Data group 10184 will be used to indicate corrected data for significant levels will follow. This information will be reported in Section 9 of PARTs B and/or D, as appropriate.

For example: If the second significant level in PART B is being corrected, the message from a land station will have the following form on Service C: IIiii TTBB YYGG/ IIiii 51515 10184 22PPP TTT_aDD ⏀.

Similarly, if corrective data for significant levels 1 and 3 in PART D are being sent, the message from a land station will have the following form on Service C: IIiii TTDD YYGG/ IIiii 51515 10184 11PPP TTT_aDD 33PPP TTT_aDD ⏀.

If an additional significant level(s) is determined after the message has been transmitted, the data will be reported as a correction message as soon as practicable. Data for more than one additional significant level may be included in the same correction message.

The additional level will be reported by means of Section 9 of PARTS B and/or D, as appropriate, in the same manner as specified for correcting previously transmitted significant levels. The Additional Data group 10186 being

used in this instance. For example: If the additional significant level is located at or below 100 mb (i.e., in PART B), the form of message on Service C for a land station will be: IIiii TTBB YYGG/ IIiii 51515 10186 //PPP TTT_aDD Ⓘ. The solidi (//) are reported in lieu of the level number normally reported for nn.

Correcting Transmitted Additional Data

When correcting transmitted Additional Data, the procedure is similar to that given in preceding paragraphs; i.e., in Section 9 in PARTS B and/or D, as appropriate. The 10188 Additional Data group will immediately precede the corrective groups which give the corrected data regardless of the data coded in the original message; i.e., if the original message had too few, too many, or incorrectly coded groups.

For example: The temperature data was reported as being doubtful between pressure values P_1P_1 and P_2P_2 by means of the 10167 group in Section 9 in PART B of the original message from a land station. It was later discovered that a correction message was necessary to rectify an error in the value reported for P_2P_2. The correction message would have the following form on Service C: IIiii TTBB YYGG/ IIiii 51515 10188 10167 $0P_1P_1P_2P_2$ Ⓘ. The corrected value for P_2P_2 being given in the correction message.

Combination Corrective Messages

Various elements may be corrected in a single message. For example: If corrective data are required for the 500-mb surface, the third significant level in PART B and a pressure value for a stratum of doubtful temperature data, they may be combined in a single message on Service C in the following form: IIiii TTBB YYGG/ IIiii 51515 10183 50hhh TTT_aDD ddfff 10184 33PPP TTT_aDD 10188 10167 $0P_1P_1P_2P_2$ Ⓘ.

The message will be arranged to use the fewest number of groups possible and at the same time preserve the clarity of the information being reported.

Correcting Transmitted Surface Data

When correcting Surface data, the additional data group 10187 will be used to indicate corrected surface data will follow. This information is reported by means of Section 9 in PART B. As surface data are reported in both PARTS A and B, the first two figures of the first data group (i.e., indicator figures 99 and 00) specify which of the PARTS is being corrected. The Correction message for surface data in PART A from a land station on Service C will have the following form: IIiii TTBB YYGG/ IIiii 51515 10187 $99P_oP_oP_oP$ $T_oT_oT_{oa}D_oD_o$ $d_od_of_of_of_o$ Ⓘ. The Correction message for surface data in PART B from a land station on Service C will have the following form: IIiii TTBB YYGG/ IIiii 51515 10187 $00P_oP_oP_o$ $T_oT_oT_{ao}D_oD_o$ Ⓘ. In reported corrective surface data for a shipboard station, the form of message is the same as that used for land stations, except the groups $99L_oL_oL_o$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ replace the land station identification group IIiii as is the case in all other correction messages for various types of data.

Correcting Transmitted Tropopause Data

When it is necessary to correct an element(s) that has been transmitted in the Tropopause Section (i.e., Section 3), the entire section shall be included in the correction message. The Additional Data group 10178 will be used to indicate that corrected tropopause data follows. The correction message will contain all three data groups of Section 3.

If the tropopause data were originally included in, or should have been included in PART A, the correction message will be reported by means of Section 9 in PART B. The correction message from a land station on Service C will have the following form: IIiii TTBB YYGG/ IIiii 51515 10178 $88P_tP_tP_t$ $T_tT_tT_{at}D_tD_t$ $d_td_tf_tf_tf_t$ Ⓘ.

If tropopause data were originally included in, or should have been included in, PART C, the correction message will be reported by means of Section 9 in PART D. The correction message from a land station on Service C will have the

following form: IIiii TTDD YYGG/ IIiii 51515 10178 $88P_tP_tP_t$ $T_tT_tT_{at}D_tD_t$ $d_td_tf_tf_t$ Ⓓ.

In reporting corrected tropopause data for a shipboard station, the forms of messages are the same as those used for land stations, except the sea Identification-Position groups (Section 1) replace the land station Identification-Position groups (Section 1).

Correcting Transmitted Maximum Wind Data

When it is necessary to correct an element(s) that has been transmitted in the Maximum Wind section (i.e., Section 4), the entire section will be included in the correction message. The Additional Data group 10179 will be used to indicate corrected maximum wind data will follow. The correction message will contain all three data groups of Section 4.

If the Maximum Wind data were originally included in, or should have been included in PART A, the correction message will be reported by means of Section 9 in PART B. The correction message from a land station will have the following form on Service C:

IIiii TTBB YYGG/ IIiii 51515 10179

$$\left.\begin{matrix} 77 \\ \text{or} \\ 66 \end{matrix}\right\} P_mP_mP_m \quad d_md_mf_mf_mf_m \quad 4V_bV_bV_aV_a \quad Ⓓ.$$

If the Maximum Wind Data were originally included in, or should have been included in, PART C, the correction message will be reported by means of Section 9 in PART D. The correction message from a land station will have the following form on Service C:

IIiii TTDD YYGG/ IIiii 51515 10179

$$\left.\begin{matrix} 77 \\ \text{or} \\ 66 \end{matrix}\right\} P_mP_mP_m \quad d_md_mf_mf_mf_m \quad 4V_bV_bV_aV_a \quad Ⓓ.$$

In reporting corrective maximum wind data for a sea station, the forms of messages are the same as those used for land stations, except the sea Identification-Position groups (i.e., Section 1) replace the land station Identification-Position groups (i.e., Section 1).

MISSING DATA

Missing Data are defined as those data which would ordinarily be observed (or computed from observed data) and included in the coded report but are not available for some reason.

Entire Report Missing

If PARTS A, B, C, and D are not available for filing at the scheduled time of the sequence collection, a short message will be filed for inclusion in the collection to explain the reason for no report.

For example: If the lack of a report was due to ground equipment failure, the message sent in the sequence collection will indicate the reason for no report by means of an Additional Data group (i.e., $101A_{df}A_{df}$). When PARTS A and/or B are missing, the reason for no report will be given in Section 9 in PART B on Service C in the following form for a land station: IIiii TTBB YYGG/ IIiii 51515 10142 Ⓓ. When PARTS C and/or D are missing, Section 9 in PART D will be reported in the following form for a land station: IIiii TTDD YYGG/ IIiii 51515 10142 Ⓓ.

NOTE: The reason for no report given in Section 9 in PART B (or PART D, as appropriate) will be transmitted at the sequence collect time in lieu of the PART A (or PART C, as appropriate) report which is not available.

If the ascent does not extend above the 100-mb level, PARTS A and B will be coded in the usual manner with the reason for termination of the ascent being reported in Section 9 in PART B. Therefore, it will not be necessary to repeat the reason for the termination in Section 9 in PART D. The inclusion of the Additional Data group 10150 in Section 9 in PART D will be sufficient to inform all concerned that data are not available above the 100-mb level.

Missing Data for Mandatory Levels

If a portion of the data for one or more of the standard isobaric surfaces is missing, the groups for the surfaces in question will be included in the message with the appropriate

missing data indicators being coded for those elements for which data are missing.

For example: If the depression of the dew point at the 500-mb surface is missing, these groups will be coded 50hhh TTT_a// ddfff. If temperature also is missing for this surface, these groups will be coded 50hhh ///// ddfff.

When the geopotential height of a standard isobaric surface is lower than the altitude of the station, the temperature-depression of the dew point group for that surface will be included in the report. Solidi (/////) will be reported for these groups (i.e., in Section 2 of PART A). The wind groups for these surfaces will be included in, or omitted from, the report as specified by the value reported for symbol I_d. When the wind groups are included for surfaces below the altitude of the station, solidi (/////) will be reported for the ddfff groups.

For example: If both the 1000- and 850-mb surfaces are below the station and the wind group is specified for inclusion by symbol I_d, the portion of the report covering these two surfaces will be coded as follows: 00hhh ///// ///// 85hhh ///// /////.....etc. If the value reported for symbol I_d specified that no wind groups were being reported in Section 2 in PART A, the five solidi shown in the preceding example for the ddfff group for each surface would be omitted.

Missing Data for Significant Levels

When Significant level data are reported in Section 5 and only the depression of the dew point for one or more Significant Levels is missing, the groups normally reported for the level (or levels) are included in their appropriate place in the message. In this case, solidi (//) will be reported for DD to indicate missing.

For example: Assuming the pressure to be 740 mb, the air temperature 5.2°C and the depression of the dew point missing for the third Significant Level, the groups are coded: 33740 052//.

Missing Wind Data

The complete report contains wind data for the surface level, the standard isobaric surfaces, the level of the tropopause, and the level of the maximum wind.

The wind group for the surface level (i.e., $d_od_of_of_of_o$) will always be included in Section 2 in PART A and in Section 5 in PART B. When data are not available, solidi will be coded for the missing parameters.

The wind groups for the standard isobaric surfaces (i.e., ddfff) will be included in, or omitted from, the message in Section 2 in PARTS A and C according to the value reported for symbol I_d. When the ddfff group must be included for a surface for which wind data are not available, five solidi (/////) will be coded for the group to indicate missing.

The wind group at the tropopause (i.e., $d_td_tf_tf_tf_t$) will be included in the message when Section 3 is reported. If the wind data are not available, solidi (/////) will be reported to indicate missing.

If wind data are not available, it is not possible to determine a level of maximum wind. Therefore, it is not necessary to establish a coding arrangement for indicating missing wind data in Section 4. In this case the group 77999 will be reported in lieu of Section 4.

DISTRIBUTION OF REPORTS

Coded radiosonde reports are distributed throughout the world over modern communication systems, both government and privately owned.

The WMO and its constituent bodies have adopted a number of standards and procedures to be followed regarding both the preparation and transmission of exchanges of these reports on an international basis. In general, most of these standards and procedures deal with the contents of the meteorological broadcasts, the time at which they are made, the headings, etc., so that a high degree of uniformity can be achieved. In general, these broadcasts provide for the transmission of meteorological reports, weather forecasts, and storm warnings, used by other meteorological services, ships, aircraft, etc.

EXAMPLE OF CODED MESSAGES

The following example will show how the data from the Adiabatic data blocks A, B, and C are encoded for transmission.

Adiabatic data block A

After final computations have been completed on the data block A (figure 3-8-12) the data will be encoded as shown in figure 3-8-14 and 3-8-17.

Adiabatic data block B

After final computations have been completed on the data block B (figure 3-8-13) the data will be encoded as shown in figure 3-8-14.

DATA BLOCK A

Code Check	TIME	PRESSURE		ALTITUDE	TEMPERATURE		REL. HUM.		DEW POINT		WIND *		REMARKS
		Contact	Mb.	Mandatory Levels	Ordinate	Ascent (°C)	Ordinate	Ascent %	Ascent (°C)	Depression	Direction Degrees	Speed (Knots)	
00	0.0		1004.0			10.7		56	-5.1	15.8	305	10	
	0.4	6.6	1000	122	64.0	9.7	25.0	66	-5.3	15.0	310	11	
11	3.9	18.3	873		67.5	-1.4	17.8	70	-8.9	7.5			
	4.7	20.5	850	1436	57.0	-2.2	11.3	75	-13.6	11.4	335	18	
22	6.9	27.9	776		54.7	-5.7	10.0	88	-10.8	5.1			
33	7.5	29.2	762		56.0	-3.3	11.5	73	-21.6	18.3			
44	8.2	30.8	746		56.8	-2.7	17.0	70	-20.0	17.3			
	9.7	35.6	700	2969	55.0	-5.3	16.0	73	-22.3	17.0	260	18	
55	11.5	41.0	650		52.8	-8.5	28.0	69	-25.1	16.6			
66	13.4	46.8	598		49.8	-12.7	39.3	61	-20.2	7.5			
77	14.4	49.2	576		49.0	-13.8	48.0	56	-25.6	11.8			
	18.2	58.3	500	5535	43.8	-21.1	50.0	52	-33.4	12.3	245	53	
88	21.0	66.2	440		37.7	-29.0	58.0	48	-41.8	12.8			
	23.4	71.9	400	7138	33.8	-34.3	62.0	43	-44.3	10.0	235	54	

Figure 3-8-12.—Data block A. 209.485

DATA BLOCK B

Code Check	TIME	PRESSURE		ALTITUDE	TEMPERATURE		REL. HUM.		DEW POINT		WIND *		REMARKS
		Contact	Mb.	Mandatory Levels	Ordinate	Ascent (°C)	Ordinate	Ascent %	Ascent (°C)	Depression	Direction degrees	Speed (Knots)	
99	25.3	76.4	366		30.9	-38.0	78.0	22	-48.0	10.0			
11	29.9	87.0	300	9101	25.0	-46.2			-		240	85	
	33.8	95.2	250	10299	21.7	-51.1			-		235	85	
22	34.4	97.2	241		21.2	-52.0			-		230	85	TROP
33	38.5	105.2	200	11750	22.3	-50.2			-		240	55	
	44.7	116.2	150	13622	21.0	-52.1			-		240	45	
	53.2	129.5	100	16209	17.4	-58.1			-		220	29	

Figure 3-8-13.—Data block B. 209.486

Symbolic form of group	Standard isobaric surface in millibars	Data to be reported					Code figure for T_a	Coded groups
		Geo-potential height of surface in gpm	Temperature in degrees C.	Depression of dew point in degrees C.	Wind direction in degrees	Wind speed in knots		
IIiii	—	—	—	—	—	—	—	72403
TTAA	—	—	—	—	—	—	—	TTAA
$YYGGI_d$	—	—	—	—	—	—	—	55121
IIiii	—	—	—	—	—	—	—	72403
$99P_oP_oP_o$	1004	—	—	—	—	—	—	99004
$T_oT_oT_{ao}D_oD_o$	—	—	10.7	15.8	—	—	6	10666
$d_od_of_of_of_o$	—	—	—	—	305	10	—	30510
00hhh	1000	122	—	—	—	—	—	00122
TTT_aDD	—	—	9.7	15.0	—	—	6	09665
ddfff	—	—	—	—	310	11	—	31011
85hhh	850	1,436	—	—	—	—	—	85436
TTT_aDD	—	—	−2.2	11.4	—	—	3	02361
ddfff	—	—	—	—	335	18	—	33518
70hhh	700	2,969	—	—	—	—	—	70969
TTT_aDD	—	—	−5.3	17.0	—	—	3	05367
ddfff	—	—	—	—	260	18	—	26018
50hhh	500	5,535	—	—	—	—	—	50554
TTT_aDD	—	—	−21.1	12.3	—	—	1	21162
ddfff	—	—	—	—	245	53	—	24553
40hhh	400	7,138	—	—	—	—	—	40714
TTT_aDD	—	—	−34.3	10.0	—	—	3	34360
ddfff	—	—	—	—	235	54	—	23554
30hhh	300	9,101	—	—	—	—	—	30910
TTT_aDD	—	—	−46.2	@	—	—	3	463//
ddfff	—	—	—	—	240	85	—	24085
25hhh	250	10,299	—	—	—	—	—	25030
TTT_aDD	—	—	−51.1	@	—	—	1	511//
ddfff	—	—	—	—	235	85	—	23585
20hhh	200	11,750	—	—	—	—	—	20175
TTT_aDD	—	—	−50.2	@	—	—	3	503//
ddfff	—	—	—	—	240	55	—	24055
15hhh	150	13,622	—	—	—	—	—	15362
TTT_aDD	—	—	−52.1	@	—	—	1	521//
ddfff	—	—	—	—	240	45	—	24045
10hhh	100	16,209	—	—	—	—	—	10621
TTT_aDD	—	—	−58.1	@	—	—	1	581//
ddfff	—	—	—	—	220	29	—	22029

@ Dew point depression not used when the temperature (TT) is -40:0°C or below.

Figure 3-8-14.—Encoding of mandatory levels from data blocks A and B.

Land Station Rawinsonde Observation

The following information is needed for starting out the RAWIN code as shown in figures 3-8-14, 3-8-17, 3-8-19 and 3-8-20.

Date: May 5

Time of observation: 1200 GMT

Station: Washington, DC

Index Number: 72403

Altitude of station: 88 meters (289 ft)

Time of release of balloon: 1130 GMT

Method of taking observation: Rawinsonde

PART A—Mandatory Levels

Mandatory levels data will be taken from adiabatic data blocks A and B and encoded as shown in figure 3-8-14.

Tropopause Data for PART A

Tropopause data will be taken from data block A and encoded as shown in figure 3-8-15.

Maximum Wind Data for PART A

Maximum wind data will be taken from data block A or B and encoded as shown in figure 3-8-16. For the vertical shear group refer to FMH-5.

Symbolic form of group	Tropopause data to be reported					Code figure for T_a	Coded groups
	Pressure in millibars	Temp. in °C.	Depression of dew point in °C.	Wind direction in degrees	Wind speed in knots		
$88P_tP_tP_t$	241	———	———	———	———	———	88241
$T_tT_tT_{at}D_tD_t$	———	−52.0	@	———	———	1	521//
$d_td_tf_tf_tf_t$	———	———	———	230	85	———	23085

Figure 3-8-15.—Encoding of tropopause data.

Symbolic form of group	Maximum wind data to be reported			Vertical shear		Coded groups
	Pressure in millibars	Wind direction in degrees	Wind speed in knots	Below max. in knots	Above max. in knots	
77 or 66 $P_mP_mP_m$	246	———	———	———	———	77246
$d_md_mf_mf_mf_m$	———	235	86	———	———	23586
$4v_bv_bv_av_a$①	———	———	———	13	29	41329①

Figure 3-8-16.—Encoding of maximum wind data.

PART A—Message Format

The following mandatory data message format will be taken directly from the coded groups column in figures 3-8-14, 3-8-15, and 3-8-16.

72403 TTAA 55121 72403 99004 10666
30510 00122 09665 31011 85436 02361
33518 70969 05367 26018 50554 21162
24553 40714 34360 23554 30910 463//
24085 25030 511// 23585 20175 503//
24055 15362 521// 24045 10621 581//
22029 88241 521// 23085 77246 23586
41329 Ⓓ

PART B—Significant Levels

Significant levels data will be taken from adiabatic data blocks A and B. and encoded as shown in figure 3-8-17.

PART B—Message Format

The following significant level data message format will be taken directly from the coded groups column in figure 3-8-17.

72403 TTBB 5512/ 72403 00004 10666 11873
01558 22776 05750 33762 03368 44746 02767
55650 08567 66598 12758 77576 13962 88440
29163 99366 38160 11300 463// 22241 521//
33200 503// Ⓓ

Symbolic form of group	Data to be reported				Code figure for T_a	Coded groups
	Level number	Pressure in millibars	Temperature in degrees C.	Depression of dew point in degrees C.		
IIiii	——	——	——	——	——	72403
TTBB	——	——	——	——	——	TTBB
YYGG/	——	——	——	——	——	5512/
IIiii	——	——	——	——	——	72403
$00P_oP_oP_o$	00	1,004	——	——	——	00004
$T_oT_oT_{ao}D_oD_o$	——	——	10.7	15.8	6	10666
11PPP	11	873	——	——	——	11873
TTT_aDD	——	——	−1.4	7.5	5	01558
22PPP	22	776	——	——	——	22776
TTT_aDD	——	——	−5.7	5.1	7	05750
33PPP	33	762	——	——	——	33762
TTT_aDD	——	——	−3.3	18.3	3	03368
44PPP	44	746	——	——	——	44746
TTT_aDD	——	——	−2.7	17.3	7	02767
55PPP	55	650	——	——	——	55650
TTT_aDD	——	——	−8.5	16.6	5	08567
66PPP	66	598	——	——	——	66598
TTT_aDD	——	——	−12.7	7.5	7	12758
77PPP	77	576	——	——	——	77576
TTT_aDD	——	——	−13.8	11.8	9	13962
88PPP	88	440	——	——	——	88440
TTT_aDD	——	——	−29.0	12.8	1	29163
99PPP	99	366	——	——	——	99366
TTT_aDD	——	——	−38.0	10.0	1	38160
11PPP	11	300	——	——	——	11300
TTT_aDD	——	——	−46.2	@	3	463//
22PPP	22	241	——	——	——	22241
TTT_aDD	——	——	−52.0	@	1	521//
33PPP	33	200	——	——	——	33200
TTT_aDDⒹ	——	——	−50.2	@	3	503//Ⓓ

NOTE: As no Additional Data groups are to be reported, Section 9 is omitted from the message. When this occurs, the end of message signal (Ⓓ) will be added immediately after the last group of Section 5.

Figure 3-8-17.—Encoding of significant levels from data blocks A and B.

DATA BLOCK C

Code Check	TIME	PRESSURE		ALTITUDE	TEMPERATURE		WIND*		REMARKS
		Contact	Mb.	Mandatory Levels	Ordinate	Ascent (°C)	Direction degrees	Speed Knots	
11	55.1	132.5	90			-60.0			
	60.7	138.9	70	18510		-56.6	230	8	
22	64.6	143.3	57			-56.0			
33	67.6	145.8	50	20601		-52.8	240	2	
	78.4	153.0	30	23908		-51.7	240	13	
44	87.0	156.8	20	26522		-53.6	240	18	
	101.8	160.3	10.0	31027		-47.0	240	30	
55	106.6	160.9	8.0	32511		-45.0			
						-			
						-			
						-			

209.487

Figure 3-8-18.—Data block C.

Symbolic form of group	Standard isobaric surface in millibars	Data to be reported					Code figure for T_a	Coded groups
		Geopotential height of surface in gpm	Temperature in degrees C.	Depression of dew point in degrees C.	Wind direction in degrees	Wind speed in knots		
IIiii	—	—	—	—	—	—	—	72403
TTCC	—	—	—	—	—	—	—	TTCC
$YYGGI_d$	—	—	—	—	—	—	—	55122
IIiii	—	—	—	—	—	—	—	72403
70hhh	70	18,510	—	—	—	—	—	70851
TTT_aDD	—	—	-56.6		—	—	7	567//
ddfff	—	—	—	—	230	8	—	23008
50hhh	50	20,601	—	—	—	—	—	50060
TTT_aDD	—	—	-52.8		—	—	9	529//
ddfff	—	—	—	—	240	2	—	24002
30hhh	30	23,908	—	—	—	—	—	30391
TTT_aDD	—	—	-51.7		—	—	7	517//
ddfff	—	—	—	—	240	13	—	24013
20hhh	20	26,522	—	—	—	—	—	20652
TTT_aDD	—	—	-53.6		—	—	7	537//
ddfff	—	—	—	—	240	18	—	24018
10hhh	10	31,027	—	—	—	—	—	10103
TTT_aDD	—	—	-47.0	—	—	—	1	471//
ddfff	—	—	—	—	240	30	—	24030

Figure 3-8-19.—Encoding of mandatory levels from data block C.

Adiabatic data block C

After final computations have been completed on the data block C (figure 3-8-18) the data will be encoded as shown in figure 3-8-19 and 3-8-20.

PART C—Mandatory Levels

Mandatory levels data will be taken from adiabatic data block C and encoded as shown in figure 3-8-19.

Tropopause Data for PART C

A tropopause was not observed above the 100-mb level, therefore, the three data groups of section 3 are replaced by the indication group 88999 which specifies a tropopause was not observed.

Maximum Wind Data for PART C

A level of Maximum Wind was not observed above the.100-mb level, therefore, the three data groups of Section 4 are replaced by the indicator group 77999 which specifies a Maximum Wind was not observed. As Section 4 is the last section to be included in PART C, the end of message signal (i.e., ⓘ will be added immediately after the indicator group (i.e., 77999 ⓘ).

PART C—Message Format

The following mandatory data message format will be taken directly from the coded groups column in figure 3-8-19.

72403 TTCC 55122 72403 70851 567//
23008 50060 529// 24002 30391 517//
24013 20652 537// 24018 10103 471//
24030 88999 77999ⓘ

PART D—Significant Levels

Significant levels data will be taken from adiabatic data block C and encoded as shown in figure 3-8-20.

PART D—Message Format

The following significant level data message format will be taken directly from the coded groups column in figure 3-8-20.

72403 TTDD 5512/ 72403 11900 581//
22570 561// 33500 529// 44200 537//
55080 451//ⓘ

Symbolic form of group	Data to be reported: Level number	Pressure in tenths of millibars	Temperature in degrees C.	Depression of dew point in degrees C.	Code figure for T_a	Coded groups
TTDD	—	—	—	—	—	TTDD
YYGG/	—	—	—	—	—	5512/
IIiii	—	—	—	—	—	72403
11PPP	11	90.0	—	—	—	11900
TTT_aDD	—	—	−58.0	—	1	581//
22PPP	22	57.0	—	—	—	22570
TTT_aDD	—	—	−56.0	—	1	561//
33PPP	33	50.0	—	—	—	33500
TTT_aDD	—	—	−52.8	—	9	529//
44PPP	44	20.0	—	—	—	44200
TTT_aDD	—	—	−53.6	—	7	537//
55PPP	55	08.0	—	—	—	55080
TTT_aDDⓘ	—	—	−45.0	—	1	451//ⓘ

NOTE: As no Additional Data groups are to be reported, Section 9 is omitted from the message. When this occurs, the end of message signal (ⓘ) will be added immediately after the last TTT_aDD group of Section 5.

Figure 3-8-20.—Encoding of significant levels from data block C.

EXERCISE (3-8-4)

Match the correct statement with each term. Enter the letter of the statement on the line preceding the term.

Term	Definition
1. ________PART A	a. Tropopause data
2. ________PART B	b. Mandatory levels
3. ________PART C	c. Maximum wind data
4. ________PART D	d. Additional data
5. ________Section 1	e. Identification-position
6. ________Section 2	f. Mandatory levels above 100 mb
7. ________Section 3	g. Mandatory levels below 100 mb
8. ________Section 4	h. Significant levels above 100 mb
9. ________Section 5	i. Significant levels below 100 mb
10. ________Section 9	j. Significant levels

UNIT 3—LESSON 9

WINDS ALOFT REPORTS

OVERVIEW

Identify the procedures for decoding and encoding winds aloft observation reports.

OUTLINE

Composition of the reports

Standard hours of observation

Reporting individual parts and sections

Missing data and corrections

Distribution of reports

Example of coded messages

WINDS ALOFT REPORTS

The winds aloft code was established to provide specific coding instructions and reporting procedures for all meteorological stations taking winds aloft observations.

The upper wind reports are designed to allow the reporting of wind conditions in the upper atmosphere. This code format is then fed into the computers for generating upper air charts, analysis and prognosis. It also provides wind information for many other types of meteorological forecasts.

Learning Objective: Identify the procedures for decoding and encoding winds aloft observation reports.

COMPOSITION OF THE REPORTS (MESSAGE)

The WMO defines a meteorological message as a message comprising a single meteorological bulletin preceded by a starting line and followed by the end of transmission signal.

The upper wind report, shown in figure 3-9-1, is composed of figure groups, each group having five figures. Each figure in each group is significant to its position in the group and to its position in the message following the section indicator or a particular self-identifying group. Therefore, the established order of the groups in the message will be maintained as indicated in the symbolic order or as specified in the instructions outlined in FMH-6.

When observed data is not available for an element, the appropriate code figure or missing indicator will be reported. This is done to preserve continuity of the group, or a number of the groups, or section, as required.

PPAA 55120 72403 44385 33518 26018 24553 44340 23554 24085 23585
44320 24055 24045 22029 77246 23586 41329

PPBB 55120 72403 90012 30510 32013 33014 90346 34515 35017 27523
90789 26013 27024 27019 91246 25518 25032 24540 9205/ 24052 23562
9305/ 24085 24585 950// 25032

PPCC 55120 72403 44370 23008 24002 24013 44220 24018 24030 77999

PPDD 55120 72403 966// 07005 9704/ 22006 02007 9838/ 23019 26020 ⊕

Figure 3-9-1.—Complete upper wind report.

Due to communication arrangements that may be in effect for your particular station, it is not practicable to specify precisely the amount of data to be transmitted.

Shipboard stations will transmit parts A, B, C, and D, insofar as data are available. Whether all the parts are included in a single message, or the parts are divided into several messages, will depend upon a number of factors which fluctuate from day to day.

Parts A and C have first transmission priority, with parts B and D having second transmission priority.

STANDARD HOURS OF OBSERVATION

The WMO Standard times of upper wind observations taken for synoptic purposes are 0000, 0600, 1200, and 1800 GMT.

If only two upper wind observations are taken per day for synoptic purposes, they will be taken at 0000 and 1200 GMT.

If more than two upper wind observations are taken per day for synoptic purposes, the ones additional to those taken at 0000 and 1200 GMT will be taken at 0600 and/or 1800 GMT, as directed.

If only one upper wind observation is taken per day for synoptic purposes, it will be taken at either 0000 or 1200 GMT by following with the instructions issued to the individual stations concerned.

Occasionally special instructions are issued regarding upper wind observations to be taken in connection with special projects, the passage of severe storms, hurricanes, etc. Upper wind observations taken in support of these special projects, or required by the storm conditions, will be taken at the times specified in the authorizations issued to the stations concerned.

REPORTING INDIVIDUAL PARTS AND SECTIONS

The WMO has clearly set forth the form of message and reporting procedures to be followed with respect to the data that must be included in reports exchanged on a hemispheric basis. For convenience in specifying the reporting procedures to be followed, the form of message has been subdivided into PARTs and Sections. The PARTs, four in number and identified as A, B, C, and D, are the larger subdivision and they are referred to in identifying the Sections (i.e., the types of data) to be included in a particular message or a collective. The Sections are the smaller subdivision and they refer to a particular type of data and the precise form of message to be used in coding the data. The Sections are numbered 1 through 4 for easy reference. When considered in reverse order, it will be noted that a Section is unique and it has the same form and reports the same type of data regardless of the PART in which it appears. Further, each PART is merely an assemblage of specified Sections. Likewise, a PART is unique with respect to the type of data it contains, as specified by the Sections included in it, and the portion of the atmosphere it covers.

PARTs A, B, C, and D

For reporting purposes, the parts divide the atmosphere horizontally into two portions at the 100-millibar (mb) surface. Only data at and below 100 millibars are reported in PARTs A and B. Only data above 100 millibars are reported in PARTs C and D. PARTs A and C provide for coding the same type of data in the same form as follows: Identification—Position (Section 1), Standard Isobaric Surfaces (Section 2) and Maximum Wind Data (Section 3). PARTs B and D provide for reporting the same type of data in the same form as follows: Identification—Position (Section 1) and Fixed Regional Levels and Significant Levels (Section 4).

The reporting of a PART is mandatory when any data required by that PART are available, unless authorized otherwise.

It will be noted that the forms of messages for both land and shipboard stations are identical, with the exception of the Identification—Position groups (i.e., Section 1). The land station report is positioned by means of the Index Number while the sea station report uses geographic coordinates for positioning.

PARTs A and C of the report are the PARTs specified for worldwide distribution and PARTs B and D are specified for distribution normally in areas of continental or subcontinental size. The WMO has specified that PARTs A and C be given reporting and transmission priority so that world-wide distribution can be completed as soon as possible. PARTs B and D are to be given secondary collection and distribution priority. This arrangement gives some countries some opportunity for flexibility in arranging the internal collection of upper wind data to meet domestic requirements.

The symbolic forms of messages of the four parts (A, B, C, and D) of the complete report are given in figure 3-9-2 for a land station and in figure 3-9-3 for a shipboard station.

Definitions of Symbolic Symbols

This section will cover the definitions of the symbolic symbols (elements and groups) as listed in figure 3-9-2 and 3-9-3 in the same general order in which they appear.

The elements will be given as they appear in the land station form and covering special instructions, if required, for the coding of the shipboard elements.

NOTE: By comparing figures 3-9-2 and 3-9-3 to figures 3-8-2 and 3-8-3, you will notice that the format has a lot in common. The symbolic letters or number will have the same meaning in each of the formats.

The code names, PILOT and PILOT SHIP, have been assigned for reference purposes only so the form and content of the report will be precisely identified by use of the code name. These code names are never included in the individual code report.

PILOT refers to an upper wind report from a land station.

PILOT SHIP refers to an upper wind report from a shipboard station.

Identification-Position (Section 1)

Section 1 contains identification of the Report and PART, day and time of observation, information on the type of wind measuring equipment used, unit of wind speed being used and identification of the station or location of the point of observation.

PPAA YYGGa_4 IIiii (LAND)

QQAA YYGGa_4 99$L_aL_aL_a$ Q$L_oL_oL_oL_o$

MMM$U_{La}U_{Lo}$ (SHIPBOARD)

All groups (land and shipboard) of this section are always reported in parts A, B, C, and D when used.

Form of Message	Contents
PART A	[Data up to and including] [100 mbs]
PPAA YYGGa$_4$ IIiii	[Identification-Position] [Section 1]
44nP$_1$P$_1$ or 55nP$_1$P$_1$ ddfff ddfff ddfff .... **44nP$_1$P$_1$ or 55nP$_1$P$_1$ ddfff ddfff ddfff**	[Standard Isobaric] [Surfaces] [Section 2]
77P$_m$P$_m$P$_m$ or 66P$_m$P$_m$P$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ or 77999 ⦶ or **7H$_m$H$_m$H$_m$H$_m$ or 6H$_m$H$_m$H$_m$H$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ or 77999 ⦶**	[Maximum Wind] [Data] [Section 3]
PART B	[Data up to and including] [100 mbs]
PPBB YYGGa$_4$ IIiii	[Identification-Position] [Section 1]
9t$_n$u$_1$u$_2$u$_3$ ddfff ddfff ddfff .... **9t$_n$u$_1$u$_2$u$_3$ ddfff ddfff ddfff ⦶**	[Fixed Regional Levels] [and Significant Levels] [Section 4]
PART C	[Data above 100 mbs]
PPCC YYGGa$_4$ IIiii	[Identification-Position] [Section 1]
44nP$_1$P$_1$ or 55nP$_1$P$_1$ ddfff ddfff ddfff .... **44nP$_1$P$_1$ or 55nP$_1$P$_1$ ddfff ddfff ddfff**	[Standard Isobaric] [Surfaces] [Section 2]
77P$_m$P$_m$P$_m$ or 66P$_m$P$_m$P$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ or 77999 ⦶ or **7H$_m$H$_m$H$_m$H$_m$ or 6H$_m$H$_m$H$_m$H$_m$ d$_m$d$_m$f$_m$f$_m$f$_m$ 4v$_b$v$_b$v$_a$v$_a$ or 77999 ⦶**	[Maximum Wind] [Data] [Section 3]
PART D	[Data above 100 mbs]
PPDD YYGGa$_4$ IIiii	[Identification-Position] [Section 1]
9 or 1 t$_n$u$_1$u$_2$u$_3$ ddfff ddfff ddfff .... **9 or 1 t$_n$u$_1$u$_2$u$_3$ ddfff ddfff ddfff ⦶**	[Fixed Regional Levels] [and Significant Levels] [Section 4]

Figure 3-9-2.—Land station (PILOT) symbolic forms.

PART A *Form of Message*	*Contents*
	[Data up to and including] [100 mb]
QQAA $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$	[Identification-Position] [Section 1]
$44nP_1P_1$ or $55nP_1P_1$ ddfff ddfff ddfff . . . . $44nP_1P_1$ or $55nP_1P_1$ ddfff ddfff ddfff	[Standard Isobaric] [Surfaces] [Section 2]
$77P_mP_mP_m$ or $66P_mP_mP_m$ $d_md_mf_mf_mf_m$ $4v_bv_bv_av_a$ or 77999 ⦶ or $7H_mH_mH_mH_m$ or $6H_mH_mH_mH_m$ $d_md_mf_mf_mf_m$ $4v_bv_bv_av_a$ or 77999 ⦶	[Maximum Wind] [Data] [Section 3]
PART B	[Data up to and including] [100 mb]
QQBB $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$	[Identification-Position] [Section 1]
$9t_nu_1u_2u_3$ ddfff ddfff ddfff . . . . $9t_nu_1u_2u_3$ ddfff ddfff ddfff ⦶	[Fixed Regional Levels] [and Significant Levels] [Section 4]
PART C	[Data above 100 mb]
QQCC $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$	[Identification-Position] [Section 1]
$44nP_1P_1$ or $55nP_1P_1$ ddfff ddfff ddfff . . . . $44nP_1P_1$ or $55nP_1P_1$ ddfff ddfff ddfff	[Standard Isobaric] [Surfaces] [Section 2]
$77P_mP_mP_m$ or $66P_mP_mP_m$ $d_md_mf_mf_mf_m$ $4v_bv_bv_av_a$ or 77999 ⦶ or $7H_mH_mH_mH_m$ or $6H_mH_mH_mH_m$ $d_md_mf_mf_mf_m$ $4v_bv_bv_av_a$ or 77999 ⦶	[Maximum Wind] [Data] [Section 3]
PART D	[Data above 100 mb]
QQDD $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$	[Identification-Position] [Section 1]
9 or 1 $t_nu_1u_2u_3$ ddfff ddfff ddfff . . . . 9 or 1 $t_nu_1u_2u_3$ ddfff ddfff ddfff ⦶	[Fixed Regional Levels] [and Significant Levels] [Section 4]

Figure 3-9-3.—Shipboard (PILOT SHIP) symbolic forms.

Code Table 1

[WMO Code 2582]

Symbol M_iM_i = Identifier Letters for a Code Form
Symbol M_jM_j = Identifier Letters for a PART of a Code Form

Name of Code Form	M_iM_i (Code Form)	M_jM_j (PART of Code Form)			
		PART A	PART B	PART C	PART D
PILOT (FM 32.V)	PP	AA	BB	CC	DD
PILOT SHIP (FM 33.V)	QQ	AA	BB	CC	DD
TEMP (FM 35.E)	TT	AA	BB	CC	DD
TEMP SHIP (FM 36.V)	UU	AA	BB	CC	DD

Figure 3-9-4.—Message identifier letters.

Definitions of the symbolic letters or numbers for Section 1 are:

NOTE: The code tables used in each figure are in reference to the code tables taken from FMH-6.

PP identifies an upper wind report from a land station using code table 1 shown in figure 3-9-4.

QQ identifies an upper wind report from a shipboard station using code table 1 shown in figure 3-9-4.

AA identifies part A of an upper wind report from either a land or shipboard station. Information contains standard isobaric surfaces from the 850 mb up to and including the 100 mb level shown in figure 3-9-4.

BB identifies part B of an upper wind report from either a land or shipboard station. Information contains fixed regional levels and significant levels from the surface up to and including the 100 mb level shown in figure 3-9-4.

CC identifies part C of an upper wind report from either a land or shipboard station. Information contains standard isobaric surfaces above the 100 mb level shown in figure 3-9-4.

DD identifies part D of an upper wind report from either a land or shipboard station. Information contains fixed regional levels and significant levels above the 100 mb level shown in figure 3-9-4.

For example: The four-letter group for PART A of an Upper Wind report from a land station will be PPAA; for PART B, the group will be PPBB, etc. The four-letter group for PART A of an Upper Wind report from a shipboard station will be QQAA; for PART B; the group will be QQBB, etc.

YYGG identifies the day and time of the observation, encoded the same as in the upper air observation.

$\mathbf{a_4}$ identifies the type of wind measuring equipment used for the winds aloft observation. Use one of the following code figures for a_4.

Code figure	Equipment
0	Pressure instrument associated with wind-measuring equipment
1	Optical theodolite
2	Radio theodolite
3	Radar
4	Pressure instrument associated with wind-measuring equipment but pressure element failed during ascent

IIiii identifies the index number, encoded the same as in the upper air observation.

$\mathbf{99L_aL_aL_a\ QcL_oL_oL_oL_o\ MMMU_{La}U_{Lo}}$ identifies the ship's position, encoded the same as in the upper air observation.

EXERCISE (3-9-1)

Match the correct definition with each term. Enter the letter of the definition on the line preceding the term.

TERM	**DEFINITION**
1. ________QQBB	**a. Type of wind equipment used**
2. ________YY	**b. Longitude**
3. ________GG	**c. Marsden square number**
4. ________a_4	**d. An upper air report from a shipboard station with information about significant levels**
5. ________IIiii	
6. ________$L_aL_aL_a$	**e. Quadrant of the globe**
7. ________Q_c	**f. Day of the month**
8. ________$L_oL_oL_oL_o$	**g. Units figure**
9. ________MMM	**h. Block and land station number**
10. ________$U_{La}U_{Lo}$	**i. Time of observation**
	j. Latitude

Standard Isobaric Surface (Section 2)

44 or **55nP_1P_1 ddfff ddfff ddfff**

Part A mandatory levels for the standard isobaric surfaces are 850, 700, 500, 400, 300, 250, 200, 150, and 100 millibars.

Part C mandatory levels for the standard isobaric surfaces are 70, 50, 30, 20, 10, 7, 5, 3, 2, and 1 millibar.

The wind group (i.e., ddfff) will be included in the message for each standard isobaric surface being reported for the ascent. If data for a standard isobaric surface(s) are missing and data are available for surfaces above and below the missing surface, five solidus (/////) will be coded for the ddfff group of the surface(s) for which data are not available. The use of the five solidi to indicate missing data is necessary to preserve the continuity of the ascending order of the standard isobaric surfaces in the message.

When any of the standard isobaric surfaces are below the earth's surface, or within 200 feet above the earth's surface, data groups for that surface and any lower surfaces will be omitted from the message.

44 indicator is used when the locations of points on the ascent curve are determined by the means of pressure (as in a rawinsonde observation).

55 indicator is used when the pressure measurements are not made and the location of points on the ascent curve are determined by the means of a linear measurement (as in a PILOT balloon observation). In other words, 55 indicates the wind speed and direction are observed at an

altitude approximately the standard isobaric surface.

The WMO has specified that altitudes constituting the best approximations to the standard isobaric surfaces will be determined regionally. WMO Region IV (i.e., North and Central America) decided that these approximate altitudes should be determined nationally, and they should be prepared by months based on climatological values.

n indicates the number of consecutive standard isobaric surfaces for which wind data are being reported, starting with the surface specified by P_1P_1.

The number of surfaces reported for n will not exceed 3. Whenever the number of consecutive surfaces to be reported are less than 3, the number (i.e., 1 or 2, as appropriate) will be coded for n.

The number of ddfff data groups following the $44nP_1P_1$ or $55P_1P_1$ group will equal the number coded for n. For example: 44385 indicates that 3 standard isobaric wind data follows the 850 mb level.

$\mathbf{P_1P_1}$ indicates the pressure of the lowest standard isobaric surface, with respect to altitude, for which the data are being reported in the ddfff groups specified by n.

The pressure of the lowest standard isobaric surface is given in tens of millibars for surfaces up to and including 100 mb (i.e., in PART A). For example: The standard isobaric surfaces of 850, 700, 500, 400, 300, 250, 200, 150, and 100 mb are reported by code figures 85, 70, 50, 40, 30, 25, 20, 15, and 10, respectively.

Above 100 mb (PART C), the pressure of the lowest standard isobaric surfaces is given in whole millibars. For example: The standard isobaric surfaces of 70, 60, 30, 20, 10, 7, 5, 3, 2, and 1 mb are reported by code figures 70, 50, 30, 20, 10, 07, 05, 03, 02, and 01, respectively.

ddfff indicates the true wind direction and speed. This group is encoded the same as in the upper air observation.

Maximum Wind Data (Section 3)

$$\left.\begin{matrix}77\\ \text{or}\\ 66\end{matrix}\right\} P_mP_mP_m \quad \text{or} \quad \left.\begin{matrix}7\\ \text{or}\\ 6\end{matrix}\right\} H_mH_mH_mH_m$$

$d_md_mf_mf_mf_m$ $4V_bV_bV_aV_a$ 77999

The only difference between the maximum wind data and the upper air observation maximum data is the 7 or 6 $H_mH_mH_mH_m$ group; otherwise, the other three groups are encoded the same.

7 is used when:

- the maximum wind occurred within the sounding;
- the maximum wind criteria are satisfied; and
- the location, with respect to altitude, of the level of the maximum wind was determined by means of linear measurement.

6 is used when:

- the greatest wind speed observed throughout the sounding occurred at the terminating level of the sounding;
- its speed is greater than 60 knots; and the location, with respect to altitude, of the level of the maximum wind was determined by means of linear measurement.

$\mathbf{H_mH_mH_mH_m}$ indicates the altitude of the level of the maximum wind reported in feet.

$H_mH_mH_mH_m$ altitude will be reported in increments of 30 feet. For example: If the level of maximum wind occurs at 42,000 feet, code figure 1400 is reported for $H_mH_mH_mH_m$ (i.e., 42,000 30 = 1400). Conversely, the altitude in feet of the level of maximum wind is obtained from a coded report by multiplying the value reported for $H_mH_mH_mH_m$ by 30.

77999 is reported for Section 3 if for any reason a maximum wind is not observed. The

77999 indicator group gives positive notification to the recipient that a maximum wind was not observed with respect to the PART in which it appears.

The 77999 group may replace Section 3 in either or both PARTs A and C provided a maximum wind is not observed in either or both the strata covered by the PARTs, and the ascent extends above 18,000 feet (i.e., 500 mb).

Fixed Regional Levels and Significant Levels (Section 4)

9 or 1 $t_nu_1u_2u_3$ ddfff ddfff ddfff

Wind data for the fixed regional levels and significant levels with respect to wind will be reported by means of Section 4 in PARTs B and D.

In coding Section 4, the fixed regional levels and significant levels will be inserted in the message in altitude sequence order so that the message progresses with respect to altitude from the surface to termination of the ascent.

FIXED REGIONAL LEVELS.—The fixed regional levels are defined as those levels at the altitudes specified by WMO regional agreement for inclusion in the report whenever data for them are available.

The altitudes of the fixed regional levels reported in PART B are:

Feet	Meters
1,000	300
2,000	600
3,000	900
4,000	1,200
6,000	1,800
7,000	2,100
8,000	2,400
9,000	2,700
12,000	3,600
14,000	4,200
16,000	4,800
20,000	6,000
25,000	7,500
30,000	9,000
35,000	10,500
50,000	15,000

The altitudes of the fixed regional levels reported in PART D are:

Feet	Meters
70,000	21,000
90,000	27,000
100,000	30,000
110,000	33,000
140,000	42,000
and for every 10,000 foot level upward	and for every 3,000 meter level upward

NOTE: As the fixed regional levels 60,000 ft (18,000 m), 80,000 ft (24,000 m), 120,000 ft (36,000 m) and 130,000 ft (39,000 m) very closely approximate the altitude of the 70-, 30-, 5-, and 3-mb standard isobaric surfaces, respectfully, wind data for these corresponding fixed regional levels are not included in PART D. Wind data for the 70-, 30-, 5-, and 3-mb surfaces are included in PART C when available. Therefore, the inclusion of these data in PART D in addition to their inclusion in PART C would be unnecessary duplication.

SIGNIFICANT LEVELS.—Defined as a level at which an abrupt change in speed and/or direction occurs.

The criteria for determining significant levels with respect to wind are based on the premise that the significant data alone should make it possible to reconstruct the wind profiles with sufficient accuracy to reconstruct the speed and direction curves within the limits of the specified criteria.

NOTE: Significant levels are selected without regard to the mandatory or fixed regional levels.

The accuracy required for practical use is to ensure that:

The direction and speed curves (in function of the log of pressure or altitude) can be reproduced with their prominent characteristics.

These curves can be reproduced with an accuracy of at least 10 degrees for direction and 10 knots for speed.

The number of significant levels be kept to a minimum.

NOTE: Significant level winds are not determined within strata of very slow speeds as the results would not be meaningful. Therefore, the significant level criteria will not be applied to those strata where the speed is 10 knots or less, regardless of the change in direction that might be occurring.

In order to satisfy the requirements given above, the following method of successive approximations is used:

The surface level and the highest level of the sounding constitute the first and last significant levels.

The deviation from the linearly interpolated values between these two levels is then considered. If no direction deviates by more than 10 degrees and no speed by more than 10 knots, no other significant level need be reported. Whenever one parameter deviates by more than the limit specified above, the level of greatest deviation becomes a supplementary significant level for both parameters. Whenever possible, the level of greatest deviation shall be taken from among the extremes of the curves.

NOTE: An extreme is understood to be a point where the vertical gradient of the parameter changes its sign.

The additional significant levels so introduced divide the sounding into several layers. In each separate layer, the base and the top are then considered. The process given above is repeated and yields other significant levels. These additional levels in turn modify the layer distribution, and the method is applied again until any level is approximated to the above mentioned specified values.

The highest level of the sounding is defined as the highest 1,000-foot level for which observed data are available. For example, if the ascent ended at 35,800 feet, the 35,000-foot level is the highest level of the sounding as it is the highest 1,000-foot level for which observed data are available.

When two significant wind levels occur within the stratum from 499 feet above to 500 feet below a reportable altitude, the significant wind having the faster speed will be reported for that altitude. In the event both the significant winds have the same speed, data for the one having the greater altitude will be reported. For example: If the two significant winds occurred within the 26,500 to 27,499 foot stratum, the reportable altitude would be the 27,000-foot level.

When a significant wind level occurs within the stratum from 499 feet above to 500 feet below a fixed regional level, the speed and direction of the significant level wind will be reported in that fixed regional level data group in lieu of the data observed at that fixed level.

When a significant level and a standard isobaric surface coincide, the data will be reported for the significant level (Section 4, PART B or PART D). In addition, the data will be reported for the standard isobaric surface (Section 2, PART A or PART C), provided PART A (or PART C) is required for inclusion in the report.

When a significant level and a level of maximum wind coincide, the speed and direction will be reported for the significant level (Section 4, PART B or PART D). In addition, the speed and direction will be reported for the maximum wind (Section 3, PART A or PART C), provided PART A (or PART C) are required for inclusion in the report.

9 indicator is used for levels below 100,000 feet and the altitudes are reported in incrememts of 1,000 feet.

1 indicator is used for levels at and above 100,000 feet and the altitudes are reported in increments of 1,000 feet.

$\mathbf{t_n}$ indicator is used to report the tens digit of the altitude, expressed in increments of 1,000 feet which applies to the data groups $u_1u_2u_3$.

The tens digit of the total number of 1,000-foot increments of altitude of a fixed regional level or a significant level is reported for symbol $\mathbf{t_n}$. Thus, if the tens digit of the number of increments is zero, as in the case of altitudes from mean sea level to 9,000 feet,

inclusive, code figure 0 shall be reported for t_n. From 10,000 to 19,000 feet, inclusive, code figure 1 will be reported for t_n. From 20,000 to 29,000 feet, inclusive, code figure 2 shall be reported for t_n, etc. From 100,000 to 109,000 feet, inclusive, code figure 0 will be reported for t_n. From 110,000 to 119,000 feet, inclusive, code figure 1 will be reported for t_n, etc.

Three levels can be reported by a $9t_nu_1u_2u_3$ (or $1t_nu_1u_2u_3$) group; however, each time the value of the tens digit represented by symbol t_n changes another $9t_nu_1u_2u_3$ (or $1t_nu_1u_2u_3$) group must be inserted in the message. Therefore, a $9t_nu_1u_2u_3$ ($1t_nu_1u_2u_3$) group can specify one, two, or three levels and be followed by one, two, or three corresponding ddfff data groups, as appropriate.

u_1 indicates the unit's digit of the altitude of the first wind data group.

u_2 indicates the unit's digit of the altitude of the second wind data group.

u_3 indicates the unit's digit of the altitude of the third wind data group.

A solidus (/) will be coded for u_2 and/or u_3 when an actual level value is not available for these symbols. When a solidus (/) is coded for either u_2 and/or u_3, the corresponding ddfff data group(s) will be omitted from the message. This procedure will be followed when the tens value reported for symbol t_n changes so that three levels cannot be specified by a single $9t_nu_1u_2u_3$ (or $1t_nu_1u_2u_3$) group and when the highest level of a PART or of the sounding is reported by either u_1 or u_2.

When data are missing for a fixed regional level, its u symbol and the corresponding ddfff data group are omitted from the report.

NOTE: The $9t_nu_1u_2u_3$ or $1t_nu_1u_2u_3$ group uniquely specifies the altitude of each level; therefore, it is not necessary to represent a fixed Regional level for which data are missing by means of solidi in order to determine the altitude of levels above the missing level(s).

As the wind data at the earth's surface is a designated significant level, it will be reported in the first ddfff data group of Section 4, PART B. Therefore, code figure 0 will be coded for the first u_1 symbol of Section 4 of PART B so that the recipient will be able to identify the surface wind.

As the wind data at the terminating level of the sounding (i.e., the highest level) is a designated significant level, it will be reported as the last ddfff data group of Section 4 of either PART B or PART D, as appropriate.

Message Separation Signal

The message separation signal (Ⓛ) will be inserted in the message as indicated in the symbolic forms of messages to mark the termination of a particular portion of the report. The separation signal will be added, without a space intervening, to the last data group of that portion of the report so that in most instances the last group will become a six-figure group.

The separation signal will be added at the end of PARTs A, B, C, and D of both the land and shipboard forms of messages. It is also added at the end of all other types of messages containing observed upper wind data as specified, e.g., messages containing corrective data, missing data, etc.

EXERCISE (3-9-2)

Match the correct definition with each term. Enter the letter of the definition on the line preceding the term.

TERM	**DEFINITION**
1. ________44	a. No maximum wind observed
2. ________n	b. Location of mandatory level made by pressure.
3. ________P_1P_1	c. Pressure of lowest mandatory level
4. ________ddfff	d. Maximum occurred within the observation
5. ________$P_mP_mP_m$	e. Number of mandatory levels
6. ________$H_mH_mH_mH_m$	f. Wind direction and speed
7. ________77999	g. Pressure at maximum wind level
8. ________7	h. Reports the tens digit of the height
9. ________9	i. Height indicator used below 100,000 feet
10. ________t_n	j. Height of maximum wind

MISSING DATA AND CORRECTIONS

In addition to the wind data normally reported for the standard isobaric surfaces, the level of the maximum wind, fixed regional levels and significant levels, it is often necessary to report other information of importance; e.g., missing data, corrections, late reports, etc. Coding procedures for reporting this additional information are given in this section.

Missing Elements and Groups

Missing data are defined as those data that would normally be observed (or computed from observed data) and are required for inclusion in the coded report but are not available for some reason.

When wind direction and/or speed are missing for any of the levels which are to be included in the coded report, solidi (//) will be coded for either, or both, the elements, as appropriate.

Occasionally it is necessary to indicate that datum for an element, other than direction and speed, is not available. In this case a solidus (/) will be coded to indicate missing data. The instructions covering this possibility are given with the detailed instructions for reporting the elements.

Instructions for coding a group by means of five solidi (/////) to indicate missing are given elsewhere in this lesson, as appropriate.

Entire Report Missing

If the entire report (i.e., either PARTs A and B or PARTs C and D) is missing at the scheduled time of transmission, the appropriate reason for no report shall be transmitted. In this instance only the Identification-Position groups (i.e., Section 1) of PARTs A and/or C, as appropriate, plus the contraction, need be included in the message.

The appropriate contraction will be selected from code table 5 (shown in figure 3-9-5) and reported by all Navy stations. The symbolic form of message (i.e., PART A) for a land station is: IIiii PPAA $YYDDa_4$ IIiii Contraction Φ. The symbolic form of message (PART A) for a shipboard station is: QQAA $YYDDa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ Contraction Φ.

If the weather is unfavorable for a launching at the time of observation but there is a possibility that the observation might be taken later, the PART A form of message for a land station is: IIiii PPAA $YYGGa_4$ IIiii PIWE Φ. The symbolic form of message (i.e., PART A) for a shipboard station is: QQAA $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ PIWE Φ. If the weather conditions continue to be unfavorable beyond the time range permitted for a late ascent so that an ascent is not made, the PART C form of message for a land station is IIiii PPCC $YYGGa_4$ IIiii PIWE Φ. The symbolic form of message (i.e., PART C) for a shipboard station is: QQCC $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ PIWE Φ.

If it is definitely known that an ascent will not be made (e.g., instrumental failure), the PART A form of message for a land station is: IIiii PPAA $YYGGa_4$ IIiii FINO Φ. In this case the form of message for a shipboard station is: QQAA $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ FINO Φ. If the inability to make the ascent continued beyond the time range permitted for a late ascent so that an ascent was not made, the PART C form of message for a land station is: IIiii PPCC $YYGGa_4$ IIiii FINO Φ. In this case the form of message for a shipboard station is: QQCC $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_o$ $MMMU_{La}U_{Lo}$ FINO Φ.

If sea conditions are such that a launching cannot be made, the PART A form of message for a shipboard station is: QQAA $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ PISE Φ. If the unfavorable sea conditions continued beyond the time range permitted for a late ascent so that an ascent was not made, the PART C form of message is: QQCC $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ PISE Φ.

Code Table 5

Contraction	Meaning
DLAD	Report not ready for transmission
FINO	Report missing, will NOT be filed for transmission
MISG	Report missing but no further information available
PISE	Unfavorable sea conditions
PIWE	Unfavorable weather conditions
XMTD	All data for the ascent has been transmitted previously

Figure 3-9-5.—Word contractions.

Delayed Report (DLAD)

When the upper wind observation has been made, or is being made, but the coded report, or PART thereof as appropriate, is not ready for transmission at the scheduled sequence collection time, the following procedures will be carried out:

The contraction DLAD means that the report has been delayed and will be sent as a late report as soon as it becomes available. The form of message of PART A for a land station is: IIiii PPAA $YYGGa_4$ IIiii DLAD Φ. The form of message of PART A for a seaboard station is: QQAA $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ DLAD Φ. There is no requirement for sending the contraction DLAD for the PART C message; hence, a form of message for this purpose has not been established.

The PART of the report for which a delayed report indicator was reported will be transmitted as a Late Report as soon as the complete coded PART becomes available.

Partial Report

If the ascent does not reach, or reaches exactly, the 100-mb surface, or the altitude approximation of the 100-mb surface, PARTs A and/or B of the report will be coded and transmitted in the normal manner without any special information being added to the report to indicate that the ascent reached less than, or exactly the 100-mb surface, or the altitude approximating that surface.

If the ascent criteria given above are met and no data are available which exceed 100-mb and a second sequence collection of upper wind reports from land stations is made, it will be necessary to enter a PART C message in the sequence collection. In this event, the coded message transmitted for PART C of the report will contain the Identification-Position (Section 1) plus the contraction XMTD and the message separation signal. The contraction XMTD means that all data for the ascent has been transmitted previously. The form of message for the PART C transmission for a land station is IIiii PPCC YYGGa_a IIiii XMTD Ⓘ. The form of message for a shipboard station is: QQCC YYGGa_4 99$L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ MMM$U_{La}U_{Lo}$ XMTD Ⓘ.

NOTE: Although rawinsonde stations would not normally report PART C, for purposes of uniformity, they will use the PART C message identifiers (i.e., PPCC or QQCC, as appropriate) for reporting the partial report.

Correcting Identification-Position Groups

When an error is discovered in the Identification-Position Groups (i.e., Section 1) of any one of the four PARTs in either the land or sea station form of message that has been transmitted, the entire PART will be recoded and transmitted as a correction message.

Correcting Standard Isobaric Surfaces

When data for any of the standard isobaric surfaces in a transmitted report are being corrected, the form of message will consist of Section 1 and the appropriate number of groups of Section 2 for PART A or PART C, as appropriate. If more than one surface is being corrected and they are not consecutive, the 44nP_1P_1 (or 55nP_1P_1, as appropriate) group will be inserted as required. For example: If the 700-mb surface from a land station is being corrected and the winds are reported at altitudes approximating the standard isobaric surfaces, the form of message is: IIiii PPAA YYGGa_4 IIiii 55170 ddfff Ⓘ. If the 700- and 400-mb surfaces are being corrected and the winds are reported at altitudes approximating the standard surfaces, the form of message is: IIiii PPAA YYGGa_4 IIiii 55170 ddfff 55140 ddfff Ⓘ. If the 700- and 500-mb surfaces are being corrected and the winds are reported at altitudes approximating the standard surfaces, the form of message is IIiii PPAA YYGGa_4 IIiii 55270 ddfff ddfff Ⓘ.

The instructions for correcting standard isobaric surfaces apply equally to both land and shipboard station reports. The forms of messages for land stations are converted to the shipboard form by use of the shipboard Identification-Position groups. For example: If the above example of the 700- and 500-mb surfaces were being corrected by a shipboard station, the form of message would be: QQAA YYGGa_4 99$L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ MMM$U_{La}U_{Lo}$ 55270 ddfff ddfff Ⓘ.

Correcting Maximum Wind

If the maximum wind in a transmitted report is discovered to be in error, the three maximum wind groups (i.e., Section 3) will be recoded and sent as a correction message. The message will consist of Sections 1 and 3 for PART A or C, as appropriate. For example: If the maximum wind transmitted in PART A of a land station report is being corrected and indicator figure 7 is appropriate, the form of message is: IIiii PPAA YYGGa_4 IIiii 7$H_mH_mH_mH_m$ $d_md_mf_mf_mf_m$ 4$v_bv_bv_av_a$ Ⓘ.

The instructions for correcting maximum wind apply equally to both the land and shipboard

station reports. In each case, Section 1 appropriate for the PART and type of Report is selected. The example used above when converted to the shipboard form of message is: QQAA $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ $7H_mH_mH_mH_m$ $d_md_mf_mf_mf_m$ $4v_bv_bv_av_a$ Ⓓ.

Correcting Fixed Regional and/or Significant Levels

When data for any of the fixed regional levels and/or significant levels transmitted in a report are being corrected, the form of message will consist of Section 1 and the required number of groups of Section 4 for PART B or PART D, as appropriate. If more than one level is being corrected, the $9t_nu_1u_2u_3$ (or $1t_nu_1u_2u_3$, if appropriate) group will be inserted as required to correctly indicate the tens digit of the number of increments of altitude being reported for the units digits coded for u_1, u_2, and u_3.

Coding examples are: If data for the 6,000-foot level and the 9,000-foot level from a land station are being corrected the form of message is: IIiii PPBB $YYGGa_4$ IIiii 9069/ ddfff ddfff Ⓓ. If data for the 6,000-foot level and the 14,000-foot level from a land station are being corrected, the form of message is: IIiii PPBB $YYGGa_4$ IIiii 906// ddfff 914// ddfff Ⓓ.

The instructions for correcting fixed regional levels and/or significant levels apply equally to both land and shipboard station reports. The forms of messages given for land stations are converted to the shipboard form by use of the ship Identification-Position groups (i.e., Section 1). If the above correction example of the 6,000- and 14,000-foot levels was being made by a shipboard station, the form of message would be: QQBB $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ 906// ddfff 914// ddfff Ⓓ.

Adding or Deleting Levels

When data for a required level has been inadvertently omitted from the report, or it is discovered that data for a level previously transmitted are doubtful, the word ADD or DELETE, as appropriate, will be included in the correction message to signify the nature of the correction. The appropriate correction message will be prepared as indicated in the preceding paragraphs with the exception that the word ADD or DELETE will be inserted in the message immediately following the Identification-Position groups (i.e., Section 1). For example: If it was discovered that data for the 13,000-foot level had been included in the report from a land station, the form of message to delete that level from the report would be: IIiii PPBB $YYGGa_4$ IIiii DELETE 913// ddfff Ⓓ. If data for the 25,000-foot level had been omitted from the report from a land station the form of message to ADD that level to the report would be: IIiii PPBB $YYGGa_4$ IIiii ADD 925// ddfff Ⓓ.

The instructions given in the above paragraph apply equally to both the land and shipboard forms of messages. The forms of both messages are identical except for the Identification-Position groups (i.e., Section 1). For example: If the data for the 25,000-foot level are to be added to a shipboard station report, the form of message would be: QQBB $YYGGa_4$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $MMMU_{La}U_{Lo}$ ADD 925// ddfff Ⓓ.

Correcting an Entire PART

If there are numerous errors in a transmitted PART, it may be more economical with respect to circuit time and less confusing to the recipient to send the entire PART in the form of a correction message rather than to attempt to correct individual groups. In this case, the data will be recorded correctly in the appropriate form of message for that PART and retransmitted as a correction message.

Heading for Corrected Reports

Headings for correction messages will be prefixed by the communicator in accordance with applicable communication instructions specified for use on the circuit of origin.

DISTRIBUTION OF REPORTS

Coded upper wind reports are distributed throughout the world over modern communication systems, both government and privately owned.

The WMO and its constituent bodies have adopted the standards and procedures to be

followed regarding both the preparation and transmission of exchanges of these reports on an international basis. In general, most of these standards and procedures deal with the contents of the meteorological broadcasts, the time at which they are made, the headings, etc., so that a high degree of uniformity can be achieved. In general, these broadcasts provide for the transmission of meteorological reports, weather forecasts, and storm warnings, used by other meteorological services, ships, aircraft, etc.

All stations making upper wind ascents will use all four PARTs (i.e., PARTs A, B, C, and D) of the Upper Wind Code to report the available data, in the symbolic forms given in figures 3-9-2 and 3-9-3. There is one exception to the above rule and that occurs when both a coded radiosonde report and a coded Upper Wind report are prepared for the same rawinsonde ascent. In that instance, wind data for the standard isobaric surfaces and the level of the maximum wind will be included in radiosonde report and those data will not be included in the Upper Wind report. Therefore, the coded Upper Wind report for that ascent will consist only of PARTs B and D.

The omission of PARTs A and C from the coded Upper Wind report (shown in figure 3-9-6) under these circumstances is done to conserve both transmission time and the observer's time by not duplicating in the coded Upper Wind Report data that have already been included in the coded Radiosonde Report.

EXAMPLE OF CODED MESSAGES

The following examples will show how the upper wind data for standard isobaric surfaces, fixed regional levels, and significant levels are encoded for transmission.

Part A—Mandatory Levels

Mandatory levels data for part A, listed in FMH-5, are encoded as shown in figure 3-9-7.

Part A—Message Format

The following mandatory levels message format will be taken directly from the coded groups column if figure 3-9-7.

72403 PPAA 55120 72403 44385 33518 26018
24553 44340 23554 24085 23585 44320 24050
24045 22029 77246 23586 41329 Φ

TTAA 55121 72403 99004 10666 30510 00122 09665 31011 85436 02361
33518 70969 05367 26018 50554 21162 24553 40714 34360 23554 30910
463// 24085 25030 511// 23585 20175 503// 24055 15362 521// 24045
10621 581// 22029 88241 521// 23085 77246 23586 41329

TTBB 5512/ 72403 00004 10666 11873 01558 22776 05750 33762 03368
44746 02767 55650 08567 66598 12758 77576 13962 88440 29163 99366
38160 11300 463// 22241 521// 33200 503//

PPBB 55120 72403 90012 30510 32013 33014 90346 34515 35017 27523
90789 26031 27024 27019 91246 25518 25032 24540 9205/ 24052 23562
9305/ 24085 24585 950// 25032

TTCC 55122 72403 70851 567// 23008 50060 529// 24002 30391 517//
24013 20652 537// 24018 10103 471// 24030 88999 77999

TTDD 5512/ 72403 11900 581// 22570 561// 33500 529// 44200 537//
55080 451//

PPDD 55120 72403 966// 07005 9704/ 22006 02007 9838/ 23019 26020 Φ

Figure 3-9-6.—Complete rawinsonde report.

Symbolic form of group	Pressure in millibars	Data to be reported				Coded groups
		Wind direction in degrees	Wind speed in knots	Vertical shear		
				Below max. in knots	Above max. in knots	
IIiii----------	----------	----------	----------	----------	----------	72403
PPAA----------	----------	----------	----------	----------	----------	PPAA
$YYGGa_4$----------	----------	----------	----------	----------	----------	55120
IIiii----------	----------	----------	----------	----------	----------	72403
$44nP_1P_1$----------	850	----------	----------	----------	----------	44385
ddfff----------	850	335	18	----------	----------	33518
ddfff----------	700	260	18	----------	----------	26018
ddfff----------	500	245	53	----------	----------	24553
$44nP_1P_1$----------	400	----------	----------	----------	----------	44340
ddfff----------	400	235	54	----------	----------	23554
ddfff----------	300	240	85	----------	----------	24085
ddfff----------	250	235	85	----------	----------	23585
$44nP_1P_1$----------	200	----------	----------	----------	----------	44320
ddfff----------	200	240	55	----------	----------	24055
ddfff----------	150	240	45	----------	----------	24045
ddfff----------	100	220	29	----------	----------	22029
$77P_mP_mP_m$----------	246	----------	----------	----------	----------	77246
ddfff----------	----------	235	86	----------	----------	23586
$4v_bv_bv_av_a$ Φ----------	----------	----------	----------	13	29	41329Φ

Figure 3-9-7.—Encoding of mandatory levels for part A.

Symbolic form of group	Altitude in feet	Data to be reported		Coded groups
		Wind direction in degrees	Wind speed in knots	
IIiii	---------	--------------	---------	72403
PPBB	---------	--------------	---------	PPBB
YYGGa$_4$	---------	--------------	---------	55120
IIiii	---------	--------------	---------	72403
9t$_n$u$_1$u$_2$u$_3$	---------	--------------	---------	90012
ddfff	Surface	305	10	30510
ddfff	1,000	320	13	32013
ddfff	2,000	330	14	33014
9t$_n$u$_1$u$_2$u$_3$	---------	--------------	---------	90346
ddfff	3,000	345	15	34515
ddfff	4,000	350	17	35017
ddfff	6,000	275	23	27523
9t$_n$u$_1$u$_2$u$_3$	---------	--------------	---------	90789
ddfff	7,000	260	31	26031
ddfff	8,000	270	24	27024
ddfff	9,000	270	19	27019
9t$_n$u$_1$u$_2$u$_3$	---------	--------------	---------	91246
ddfff	12,000	255	18	25518
ddfff	14,000	250	32	25032
ddfff	16,000	245	40	24540
9t$_n$u$_1$u$_2$u$_3$	---------	--------------	---------	9205/
ddfff	20,000	240	52	24052
ddfff	25,000	235	62	23562
9t$_n$u$_1$u$_2$u$_3$	---------	--------------	---------	9305/
ddfff	30,000	240	85	24085
ddfff	35,000	245	85	24585
9t$_n$u$_1$u$_2$u$_3$	---------	--------------	---------	950//
ddfff⦶	50,000	250	32	25032⦶

Figure 3-9-8.—Encoding of fixed and significant levels for part B.

Symbolic form of group	Pressure in millibars	Data to be reported		Coded groups
		Wind direction in degrees	Wind speed in knots	
IIiii ----------	----------	----------	----------	72403
PPCC ----------	----------	----------	----------	PPCC
$YYGGa_4$ ----------	----------	----------	----------	55120
IIiii ----------	----------	----------	----------	72403
$44nP_1P_1$ ----------	70	----------	----------	44370
ddfff ----------	70	230	8	23008
ddfff ----------	50	240	2	24002
ddfff ----------	30	240	13	24013
$44nP_1P_1$ ----------	20	----------	----------	44220
ddfff ----------	20	240	18	24018
ddfff ----------	10	240	30	24030
77999Ⓘ ----------	----------	----------	----------	77999Ⓘ

Figure 3-9-9.—Encoding of mandatory levels for part C.

Part B—Fixed and Significant Levels

The fixed and significant levels data for part B, listed in FMH-5, are encoded as shown in figure 3-9-8.

Part B—Message Format

The following fixed and significant levels message format will be taken directly from the coded groups column in figure 3-9-8.

72403 PPBB 55120 72403 90012 30510 32013 33014 90346 34515 35017 27523 90789 26013 27024 27019 91246 25518 25032 24540 9205/ 24052 23562 9305/ 24085 24585 950// 25032 Ⓘ

Part C—Mandatory Levels

Mandatory levels data for part C, listed in FMH-5, are encoded as shown in figure 3-9-9.

Part C—Message Format

The following mandatory levels message format will be taken directly from the coded groups column in figure 3-9-9.

72403 PPCC 55120 27403 44370 23008 24002 24013 44220 24018 24030 77999 Ⓘ

Part D—Fixed and Significant Levels

The fixed and significant levels data for part D, listed in FMH-5, are encoded as shown in figure 3-9-10.

Part D—Message Format

The following fixed and significant levels message format will be taken directly from the coded groups column in figure 3-9-10.

72403 PPDD 55120 72403 966// 07005 9704/ 22006 02007 9838/ 23019 26020 Ⓘ

Symbolic form of group	Altitude in feet	Data to be reported		Coded groups
		Wind direction in degrees	Wind speed in knots	
IIiii	----------	--------------	----------	72403
PPDD	----------	--------------	----------	PPDD
$YYGGa_4$	----------	--------------	----------	55120
IIiii	----------	--------------	----------	72403
$9t_nu_1u_2u_3$	----------	--------------	----------	966//
ddfff	66,000	70	5	07005
$9t_nu_1u_2u_3$	----------	--------------	----------	9704/
ddfff	70,000	220	6	22006
ddfff	74,000	20	7	02007
$9t_nu_1u_2u_3$	----------	--------------	----------	9838/
ddfff	83,000	230	19	23019
ddfffⓓ	88,000	260	20	26020ⓓ

Figure 3-9-10.—Encoding of fixed and significant levels for part D.

UNIT 4

DATA PREPARATION AND DISPLAY

FOREWORD

The basis for successful operation of any watch section, in a weather office, is the partnership between the observer/plotter and the forecaster. Your job, as the observer/plotter, is to provide the forecaster with up-to-date data (accurate, complete, and neatly plotted charts; teletype; and color enhanced facsimile and locally produced charts). Unit Three exposed you to the necessary plotting skills. In this Unit you will learn to (a) recognize the different teletype headings and their significance to the forecaster (Lesson 1: Filing Teletype Reports) and (b) prepare, label, and display weather charts (Lesson 2: Chart Preparation and Representation).

UNIT 4—LESSON 1

FILING TELETYPE REPORTS

<u>OVERVIEW</u>

Identify teletype heading and their importance to the forecaster.

<u>OUTLINE</u>

Weather Communications

Teletype Message Headings

Significant Data

A large amount and variety of weather data reaches your weather office via teletype and facsimile communications. Facsimile data is covered in the next lesson. Each teletype message received may hold an integral part of the on-going puzzle your forecaster is trying to solve. "What's the weather gonna do?" Prompt display of this data generally brings it to your forecaster's attention. But only if you post it on the proper board in the display system used at your office.

Learning Objective: Identify and interpret MANOP Headings of weather messages.

WEATHER COMMUNICATIONS

Weather communications for Department of Defense (DOD) weather services like our own Naval Oceanographic Command and Air Weather Service (AWS) of the Air Force are directed by both Air Force Communications Service (AFCS) and AWS regulations (AWSR) 105-2, Volume I, *Weather Communications*. The entire AFCSR 105-2 series is referred to as the Manual of Operations or MANOP.

TELETYPE MESSAGE HEADINGS

Weather messages are assigned abbreviated headings designed to aid identification and display. The abbreviated headings are called MANOP Headings.

A message heading is composed of printed groups in the following symbolic format:

TTAA (ii)CCCC(k)YYGGgg(BBB)

Each term can be explained as follows:

TT: This is the designator for the type data.

AA: These letters indicate the geographical location.

(ii): These two digits are used to differentiate between more than one bulletin containing data in the same code, originating from the same geographic area and the same originating station. The U.S., for example, is divided into circuits which are numbered with a two-digit identifier. Circuit breakdown aids the collection of the huge amount of similar data that would have to be collected under one MANOP Heading. Airways reports, hourlies and specials, from the

several hundred U.S. stations are conveniently broken into smaller messages by the circuit divisions.

CCCC: A four-letter location indicator of the station originating or compiling the message.

(k): This is not used by DOD weather units.

YY: Day of the month

GGgg: Time (hours and minutes) of message in GMT.

(BBB): Indicator that a change has taken place in an otherwise regular meteorological message authorized indicators are:

- RTD—Routine delayed weather.
- COR—Corrections to a message.
- AMD—Amendment to a message.

Data Designators

A breakdown of the data designator can be found in AWSR 105-2, Volume I, Attachment 1. Appendix XI, (found at the end of the manual) duplicates part of that listing in Attachment 1. Notice that the data designators for *surface* type data all begin with the letter "S". Similarly, *upper* air data is "U", *climatic* data is "C", etc. Obviously the first letter of the designator hints toward the type of data. Sometimes the second letter of the designator offers a further hint, but you must look for your own pattern of identification to help you.

Geographical Designators

Geographical designators are listed in AWSR 105-2, Volume I, Attachment 2. Every attempt has been made to make the designator resemble the geographical name. A list in Appendix XI shows this to be true.

FOUR-LETTER CALL SIGN.—The above geographical designators are not to be confused with the four-letter international call sign used to report individual hourlies and forecasts. For example LERT for Rota, Spain or EGKK for London/Gatwick International Airport are international call signs. These call signs can be found in AWSR 105-2, Volume II, Chapter 3.

SIGNIFICANT DATA

During the course of your watch as the "OBSERVER" you will tear, cut, and file yards and yards of teletype paper. All of this teletype paper has data on it but some data are more significant than others to your "FORECASTER." The following data are generally considered to be important pieces to the forecaster. Ask your forecaster which data he/she wants brought to their immediate attention, then do it.

Terminal Forecasts (FTs)

There are three prevalent types of terminal forecast. They are the U.S. Terminal Forecast (FT), issued by the National Weather Service; the Plain Language Terminal Forecast (PLATF), issued by the U.S. Navy (FT); and the Terminal Aerodrome Forecast (TAF), a coded forecast used by the military (FT) and civilian stations (FT).

Most terminal forecast messages have a heading which identifies the data that follows. In the example below, the "FT" identifies the data as a military terminal forecast. This is followed by the area being sent (72) and the sending station (KAWN), Carswell Air Force Base computer center in this case. The next six digits (042045) are the date and time group denoting transmission time. The next line includes a four-digit number right after the station identifier (NBG) to indicate the time the complete 24-hour forecast begins and the time it ends (2121). The times given in the left-hand margin indicate the time the weather for that line is expected to begin.

```
FTUS 72 KAWN 042045
NBG 2121 6 OVC 2F 0105 QNH 30.13
      03Z 2 OVC 1/2F 0208 QNH 30.16
      14Z 5 BKN 12 OVC 3R-F 0510 QNH 30.10
```

These forecasts (see figure 4-1-1) are filed on teletype display board for the forecaster's use as flights occur to these various areas.

PLATF FORMAT

```
FTUS 72 KAWN Ø421ØØ

NQA   2121 1Ø OVC 2S--F Ø4Ø6 VSBY 2V5 QNH 3Ø.22
      TEMPO 8 OVC 1S--F Ø6Ø8
      18Z 1Ø BKN 3Ø OVC 6H Ø9Ø8 RW VCNTY QNH 3Ø.15

NBG   2121 6 OVC 2F Ø1Ø5 QNH 3Ø.13
      Ø3Z 2 OVC 1/2LF Ø2Ø8 QNH 3Ø.16
      14Z 5 BKN 12 OVC 3R-F Ø51Ø QNH 3Ø.1Ø

NPA   2121 1Ø OVC 3F 351Ø VSBY 2V4 QNH 3Ø.Ø9
      Ø3Z 4 BKN 1Ø OVC 2F Ø1Ø8 VSBY 1V3 QNH 3Ø.11
      Ø8Z 2X 1/2F Ø2Ø6 OCNL ØX 1/4F QNH 3Ø.16
      17Z 8 BKN 3F 351Ø BKN V OVC QNH 3Ø.14
```

FT FORMAT

```
FT LA Ø3224Ø
LCH  Ø32323 C6 OVC 5H Ø112G OCNL C4 OVC 2L-F CHC TRW. Ø2Z C4 OVC 2F
     Ø112G OCNL R-. 15Z C8 OVC 4H Ø415G. 17Z IFR. .
SHV  Ø32323 C4 OVC 4F 361Ø CHC ZL-IP-. 16Z C2Ø OVC Ø21Ø. 17Z MVFR. .
```

TAF FORMAT

```
KLF1   1212 Ø2ØØ8 16ØØ 6ØRA 44FG 8STØØ4 64Ø8Ø6 3ØØØINS CIGØØ4
       INTER 1216 ØØØØØ Ø8ØØ 45FG 9//ØØ1 CIGØØ1
       GRADU 1617 Ø2Ø11 6ØØØ Ø6HZ 5STØØ7 6SCØ2Ø 2CS3ØØ 67Ø7Ø8
       QNH 2993INS CIGØØ7 OCNL RA
       INTER 1822 19ØØ6 48ØØ 8ØRASH 3STØØ9 7CUØ2Ø CIGØ2Ø

KNBG   1212 36ØØ7 Ø8ØØ 5ØDZ 45FG 9//ØØ2 QNH 3ØØ1INS CIGØØ2
       GRADU 1516 Ø2Ø11 8ØØØ Ø6HZ 5STØØ7 6SCØ2Ø 2AS14Ø 2CS3ØØ 6214Ø3 54Ø2Ø9
       QNH 2995INS CIGØØ7 OCNL RA
       INTER 1822 16ØØ8 48ØØ 8ØRASH 3STØØ8 7CUØ2Ø CIGØ2Ø

KSTL   1212 ØØØØØ Ø8ØØ 5ØDZ 45FG 9//ØØ1 QNH 3ØØ4INS CIGØØ1
       GRADU 1314 12ØØ6 16ØØ 44FG 8STØØ5 2CS3ØØ QNH 3ØØ7INS CIGØØ5
       OCNL RA
       GRADU 1718 17Ø1Ø 8ØØØ Ø6HZ 3STØØ7 6SCØ2Ø 2CS3ØØ 65Ø1Ø6 54Ø2Ø9 QNH 2991INS
       CIG Ø2Ø RASH VCNTY
       INTER 1823 18Ø15 48ØØ 8ØRASH 5CUØ2Ø CIGØ2Ø
       GRADU Ø1Ø2 15ØØ5 32ØØ 44FG 6STØØ5 8SCØ2Ø 2SC3ØØ QNH 3ØØØINS CIGØØ5
```

Figure 4-1-1.—Terminal forecast formats.

```
FAUS KMSY 041240
041300Z - 050700Z
OTLK 050700Z - 051900Z

TN AR LA MS AL FL W OF 85 DEG CSTL WTRS

HGTS MSL UNLESS NOTED

TSTMS IMPLY PSBL SVR OR GTR TURBC. . .SVR ICG. . .AND LOW-LVL WIND
SHEAR. . .

FLT PRCTN. . .OVR ERN TX LA MS AL OCNL CIG BLO 10 VSBY BLO 3R-F. CONDS
SPRDG SEWP OVR FL AND CSTL WTRS BY 18Z. CONDS IMPVG OVR AREA FM
THE NW 20Z-04Z.

SYNS. . .STNRY FNT ACRS SPN GA TO SE AL SWD INTO CNTRL GULFMEX. CLD
HI CNTRD OVR MO WL MOV EWD WTH RDG TO SRN TX CONTG.

SIGCLD AND WX. . .

SE OF LFK-BWG LN. . .
CIGS BLO 1 THSD FT VSBYS FQTLY BLO 3 MI IN PCPN AND FOG. TOPS CLDS 70
NW PTN AREA TO 120 NW FL. SCTD EMBDD TSTMS OVR NW FL AND ADJ CSTL
WTRS. ONCL ZR-ZL IN BAND ABT 75 MI WIDE FM SW LA NEWD TO MDL TN
TILL 18Z. AFT 18Z OVR W HALF TN CIGS 30-40 BKN TO OVC WITH LTLCHG
ELSW. OTLK. . .VFR OVR TN IFR RMNDR AREA.

NW OF LFK-BWG LN. . .
CIGS 10-20 OVC TO BKN FOR ABT 100 MI NW OF LN BCMG CIGS 30-40 OVC TO
BKN MORE THAN 100 MI NW OF LN AND CLR OVR NW THIRD AR. TOPS CLDS
70. OTLK. . .VFR OVR AR AND WRN TN. MVFR ELSW.

ICG AND FRZLVL. . .OCNL MDT-SVR ICGICIP GENLY BLO 5 THST FT OVR TN
NW AL MOST OF MS AND LA. FRZLVL SFC AR SLPG TO 120 FL CSTL WTRS.

TURBC. . .NO SIG TURBC EXPCTD.

THIS FA ISSUANCE INCORPORATES THE FOLLOWING STILL IN EFFECT. . .SIERRA 3.
```

Figure 4-1-2.—Area forecast (FA).

Area Forecasts (FAs)

The area forecast (as depicted in figure 4-1-2) is a teletype presentation with a teletype identifier of "FAUS." Area forecasts are issued by selected Weather Service Forecast Offices (WSFO) and cover an equivalent to several states. These forecasts are intended primarily for use in preflight planning the en route portion of medium-haul domestic flights. The forecasts are prepared every 12 hours and give a detailed FORECAST for an eighteen-hour period with a general outlook for an additional twelve-hour period.

The heading of the area forecast consists of the teletype identifier, FAUS, for area forecast from the United States, followed by the international four-letter identifier for the originating WSFO, and the transmission date-time group.

The next two lines give the valid time of the forecast and valid time of the outlook period.

FAUS—Teletype identifier for area forecast within the U.S.

KMSY—Identifier of the originating forecast center, "K" for international dissemination, "MSY" for Moisant Airport, New Orleans, LA.

041200—Date-time group of transmission time over teletype.

041300Z-050700Z—Forecast period for next 18 hours.

OTLK 050700Z-051900Z—Forecast Outlook for additional 12 hours.

These are filed on the display boards and are generally used by your forecaster to keep up with what other forecasters are calling for in your area. Their primary use would be as a source of information for briefing a cross-country flight across these various regional areas.

In-Flight Weather Advisories (SIGMET's & AIRMET's)

In-flight weather advisories are teletype presentations with the letter identifiers WST (CONVECTIVE SIGMET), WS (NONCONVECTIVE SIGMET), and WA (AIRMET), which are issued individually and their information may be included in the relevant portions of the Area Forecasts (FAs). These individually issued advisories automatically amend the relevant portion of the FA for the period of the advisory; however, a separate FA amendment can also be issued whenever a significant change occurs. The in-flight advisories are intended primarily to provide en route aircraft with information concerning weather which may be hazardous to flight.

In-flight weather advisories (figure 4-1-3) consist of three types—AIRMET (WA), SIGMET

```
MKCC WST Ø71255
CONVECTED SIGMET 1ØC
TX
FROM 6ØNNE ABI TO 2ØN DFW TO 3ØN AUS TO 4ØESE SJT
AREA EMBDD TSTMS MOVG FROM 272Ø. MAX TOPS TO 3ØØ.

FCST TO 1455Z
AREA WL MOV EWD 2Ø KT THRU 1455Z.
```

```
WBC WS Ø61815
SIGMET MIKE 2 Ø61815-Ø62215
WV VA MD DC DE NC SC.
FM 6Ø NE PKB TO 1ØØ N SBY TO ORF TO ELW TO 6Ø E CHA.
MDT TO OCNL SVR TURBC AOB 12Ø OVR AND LEE OF MINS. RPTD BY ACFT.
CONT ADVY BYD 2215Z.
```

```
WBC WS Ø62ØØ5
CNCL SIGMET NOVEMBER 1. NO FRTHR RPTS RCVD. ICG EXP TO BE MSTLY MDT.
```

```
WBC WA Ø6113Ø
AIRMET WHISKEY 2 Ø6123Ø-Ø6133Ø
WV VA MD DC NC SC.
FM 5ØNE EKN TO BWI TO 3ØNW AGS TO 6ØE CHA TO BRG.
OCNL MDT TURBC BLO 12Ø. CONT ADVY BYD 133ØZ.
```

Figure 4-1-3.—Examples of in-flight weather advisories 9 (SIGMET's and AIRMET's).

(nonconvective) (WS), and the SIGMET (convective) (WST). AIRMETs WA (Airmen's Meteorology Information) are issued for weather that may be hazardous to single engine, light aircraft and aircraft not IFR equipped. SIGMETs WS/WSTs (Significant Meteorological Information) apply to all aircraft.

In-flight weather advisories WS/WAs are identified with a letter and a number beginning at 0000 GMT by the issuing office. The WS's alphanumeric series is "ALPHA thru NOVEMBER" while WAs are assigned "OSCAR thru ZULU." The first WS is identified as "ALPHA 1" and each related SIGMET retains

```
MKC WW 21Ø237

BULLETIN - IMMEDIATE BROADCAST REQUESTED
TORNADO WATCH NUMBER 21
NATIONAL WEATHER SERVICE KANSAS CITY MO
94Ø PM CST WED FEB 2Ø 19XX

A......THE NATIONAL SEVERE STORMS FORECAST CENTER HAS ISSUED A
       TORNADO WATCH FOR
                A LARGE PORTION OF OKLAHOMA
                A LARGE PORTION OF CENTRAL TEXAS

       FROM 1Ø PM CST UNTIL 4 AM CST THIS THURSDAY MORNING.

       TORNADOES. . .LARGE HAIL. . .AND DAMAGING THUNDERSTORM
       WINDS ARE POSSIBLE IN THESE AREAS.

       THE TORNADO WATCH ARE IS ALONG AND 7Ø STATUTE MILES EITHER
       SIDE OF A LINE FROM 25 MILES NORTH OF OKLAHOMA CITY OKLAHOMA
       TO 35 MILES SOUTHEAST OF BROWNWOOD TEXAS.

       REMEMBER. . .A TORNADO WATCH MEANS CONDITIONS ARE FAVORABLE
       FOR TORNADOES AND SEVERE THUNDERSTORMS IN AND CLOSE TO THE
       WATCH AREA. PERSONS IN THESE AREAS SHOULD BE ON THE LOOKOUT
       FOR THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER
       STATEMENTS AND POSSIBLE WARNINGS.

B......OTHER WATCH INFORMATION. . .THIS TORNADO WATCH REPLACES
       TORNADO WATCH NUMBER 2Ø. WATCH NUMBER 2Ø WILL NOT BE IN
       EFFECT AFTER 1Ø PM CST.

C......TORNADOES AND A FEW SVR TSTMS WITH HAIL SFC AND ALF TO 1 IN.
       EXTRM TURBC AND SFC WND GUSTS TO 65 KT. SCTD CBS WITH MAX
       TOPS TO 48Ø. MEAN WIND VECTOR 24Ø4Ø.

D......LN OF TSTMS MOVG EWD AT ABT 25 KT AS CELLS MOV NEWD ABT 4Ø KT.

.......DAVIDS.......
```

Figure 4-1-4.—Severe weather watch bulletin (WW).

the same letter designator until cancelled, but is given the next number—i.e., "ALPHA 2." This automatically cancels the preceeding lettered and numbered advisory. FOR EXAMPLE: SIGMET BRAVO 2 cancels SIGMET BRAVO 1, and AIRMET PAPA 2 cancels AIRMET PAPA 1.

Severe Weather Watch Bulletins (WWs)

Severe weather watch bulletins (figure 4-1-4) are teletype presentations which have as their teletype identifier the letters "WW." Aviation severe weather watch bulletins originate at the National Severe Storms Forecast Center (NSSFC) which is located in Kansas City, Missouri (MKC). You may also hear "WWs" referred to as severe weather forecasts.

Notice that it is arranged in several paragraphs giving such information as the area of coverage, the valid time of the forecast, the expected type of severe weather, the mean wind vector, and any amplifying remarks deemed necessary.

EXERCISE (4-1-1)

1. Match the data designator in Column B with the type of data in Column A (Refer to Appendix XI).

COLUMN A	COLUMN B
a.________ PIREP	1. SA
b.________ Radar Report	2. FT
c.________ Weather warning	3. WW
d.________ Forecast (TAF), valid over 12 hours	4. SM
e.________ Airways reports	5. WH
f.________ Surface analysis	6. AS
g.________ Hurricane warning	7. UA
h.________ Synoptic main hours	8. SD

2. What is the geographical designator for:

a. Alaska____________

b. North Atlantic____________

c. Canada____________

3. List the three types of in-flight weather advisories.

a. ____________

b. ____________

c. ____________

UNIT 4—LESSON 2

CHART PREPARATION AND REPRESENTATION

OVERVIEW

The preparation, labeling, and display of weather charts.

OUTLINE

Preparation

- Identification Block
- Past History

Representation

- Chart Labeling
- Display

Learning Objective: Give the meaning of selected weather map symbols, and indicate the shading, symbol, and color used for selected weather features.

PREPARATION

Before any weather chart can convey meaning to its user it must be able to answer some basic questions at a glance:

1. What chart is it?
2. What time is it valid for?
3. What were the conditions like before (how much has changed since the last chart was drawn)?

These questions can generally be answered by looking at the *identification block* and observing the displayed *past history*.

IDENTIFICATION BLOCK

Facsimile Charts

Facsimile (FAX) charts are printed with their information already outlined on them (see figure 4-2-1). Generally, this data needs to be enhanced for easy visibility. You can re-label the chart in the lower left hand corner using large felt tip pens providing only the LEVEL and the DATE/TIME.

Hand-drawn Charts

Locally provided or hand-drawn charts are normally of a much larger size than the FAX charts. There is a rubber stamp used to provide the IDENTIFICATION BLOCK as seen in figure 4-2-2. Because of its larger size it is not necessary to re-label the chart. Although that decision rests with your forecaster.

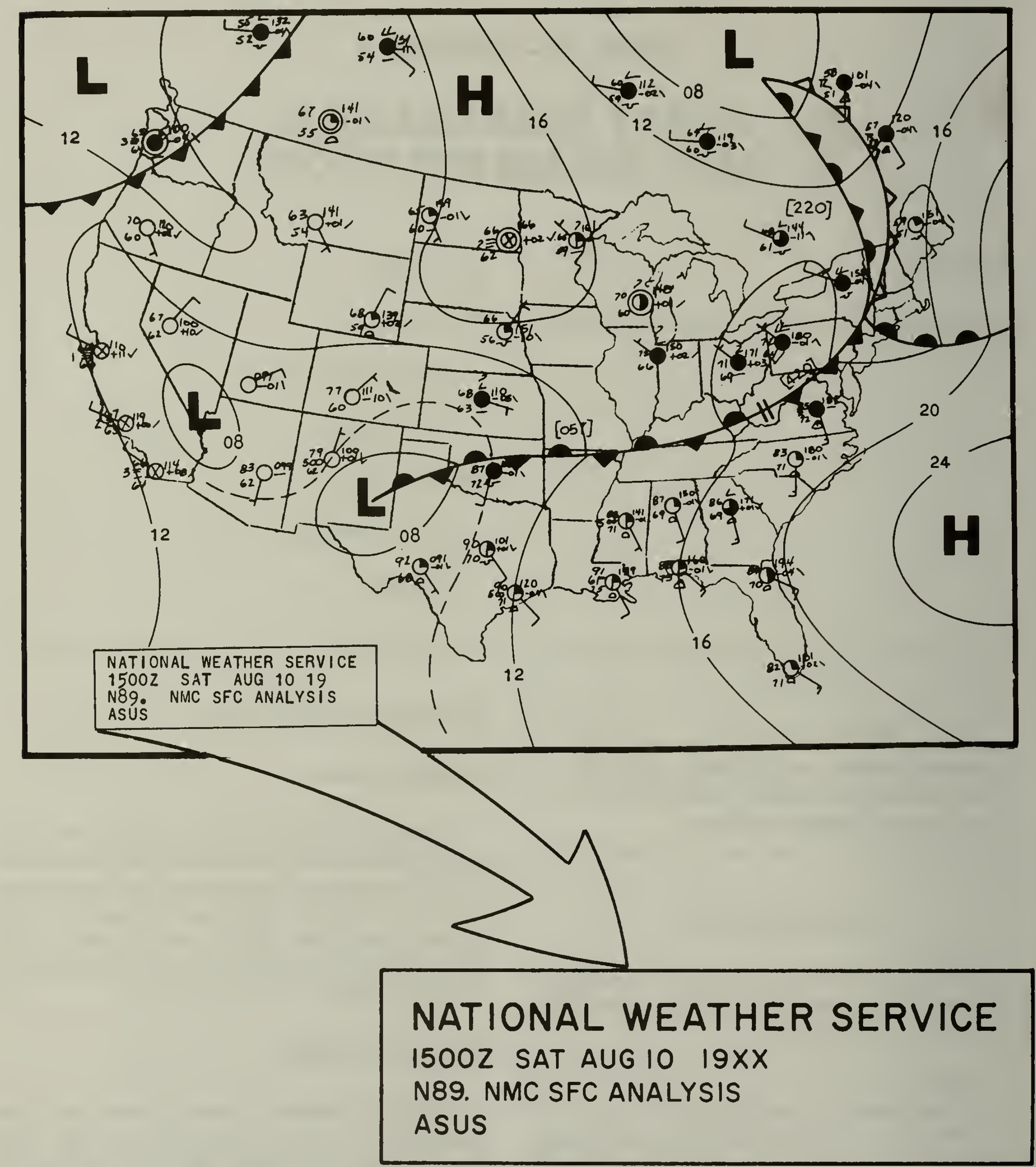

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Figure 4-2-1.—Information block on a facsimile chart.

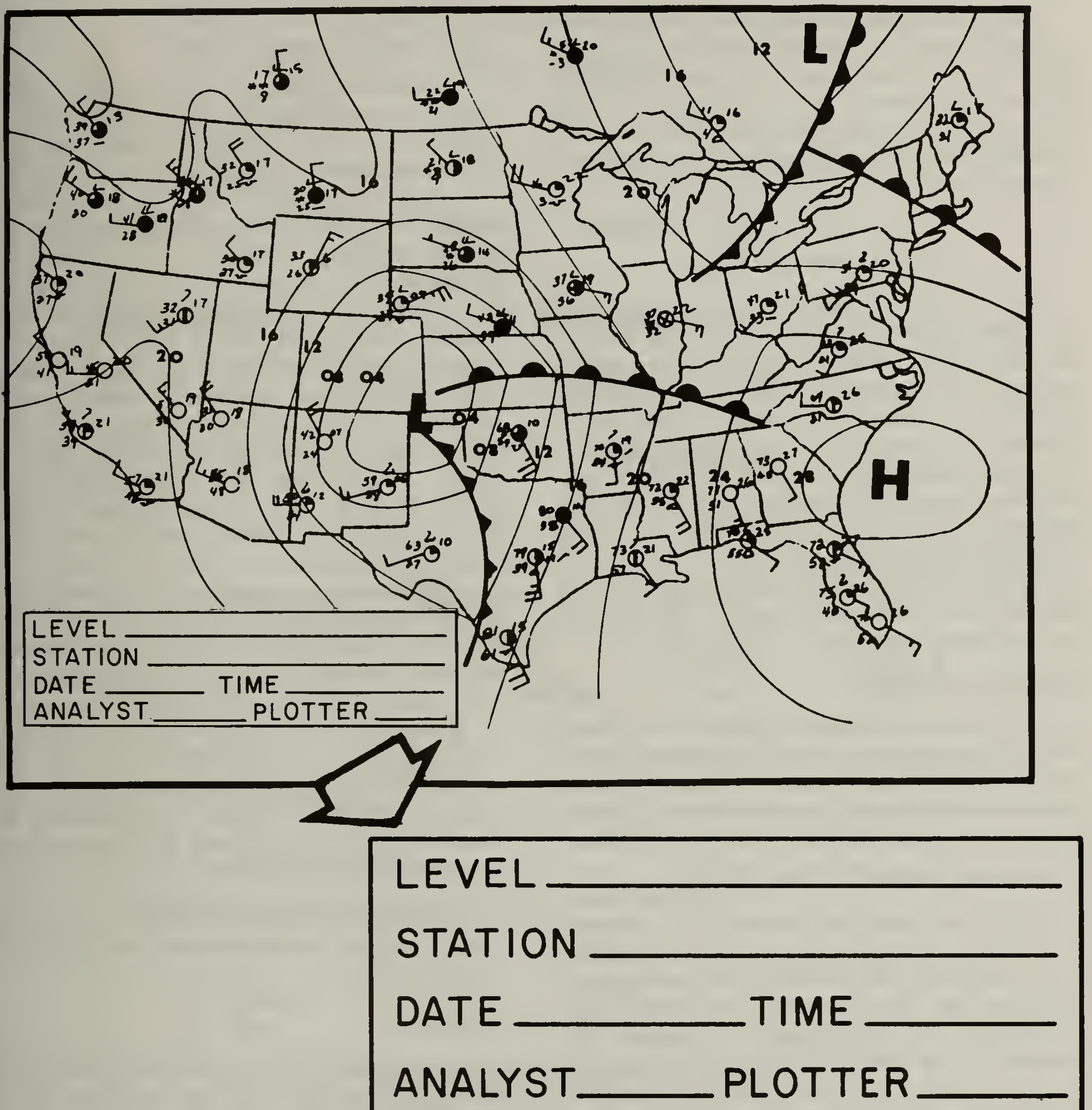

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Figure 4-2-2.—Information block on a locally prepared chart.

PAST HISTORY

Past history includes the previous locations of fronts, pressure centers, and other analysis features as traced from previously analyzed charts. The amount of past history (6 hrs, 12 hrs, 24 hrs, etc.) that is required on a chart is determined by your forecaster. Past history is normally entered in YELLOW.

REPRESENTATION

The worth of all weather charts starts with the reliability of the plotted data and the skill of the Analyst/Forecaster to capture that level or state of the atmosphere. That worth is further enhanced by using the proper techniques of labeling and display of these weather charts. Forecasters may prefer to label and "color-in" their own charts. But the odds are they will leave that, as well as the FAX charts, for you as the "OBSERVER" to color-in.

Of course it is your responsibility to post (display) all of these charts so that they provide the maximum assistance to the forecaster.

CHART LABELING

The display of weather features on a map calls for a sign language that is descriptive of the data being presented. Symbols, lines, shading, and color are arranged in combinations to show the more important weather features at a glance.

Frontal and Instability Line Features

Fronts are important features of a weather map. They are classified as cold, warm, stationary, or occluded. Most of the fronts are depicted at surface, but sometimes they are shown aloft. The symbol for fronts does not indicate the strength of the front. However, separate symbols are used for fronts that are forming (frontogenesis) or breaking down (frontolysis). When you use color to show a front, blue is for cold, red for warm, purple for occluded, and alternate red and blue for stationary.

Though not strictly classed as a front, an instability line travels ahead of some cold fronts and brings some very violent weather with it. This important feature is shown in black color on the map. Figure 1 in Appendix XIV shows the symbols and colors for the common frontal features. You should become familiar with the symbols and colors for each term.

Other Weather Map Features

Additional important features of a weather map are zones of precipitation, areas of storms, or areas where visibility for flying is restricted. These features are shown by shading, color, and symbol.

When you use color, show zones of precipitation in green. Shading indicates the type of precipitation, whether it be continuous, intermittent, or showery. Figure 2 in Appendix XIV shows the shading schemes for these three types. Since no shading is used for showery areas, indicate these areas by distributing the appropriate shower symbols for rain, snow, or hail over the area. Make them green when using color. Symbols may be distributed over the zones of continuous and intermittent precipitation as well. Use the appropriate symbol (green, except for freezing precipitation, which should be in red).

Thunderstorms, tornadoes, and funnel clouds are shown only by symbol, and the symbols are in red. Place these symbols as close to the reporting station as possible so as not to create the illusion of a larger area of storm than really exists.

Restrictions to flying visibility take on several forms, most commonly fog, dust, sand or haze. Both shading and symbols depict these areas on the map. Yellow, solid shading and symbols indicate fog. Brown, solid shading with the proper symbols indicate the other phenomena.

NOTE: The suggested standard representation of analyses and prognoses can be found in Appendix XIV.

DISPLAY

As was mentioned earlier the primary purpose in arranging chart display is to aid the forecaster. Several different methods can be used; two are presented here. The most visual system has the charts arranged in chronological sequence with the latest chart at the right and the oldest chart at the extreme left of the display. A history of the last 24 hours for analyses and a projection of the next 72 hours for prognoses should always be visible. If space is limited "stack" the charts with the most recently analyzed chart on top.

EXERCISE (4-2-1)

NOTE: Review Appendix XIV before proceeding with this exercise.

1. What color is used to indicate past history?

- a. Red
- b. Yellow
- c. Blue
- d. Green

2. Give the meaning for each of the symbols depicted.

a.  ____________ d.  ____________

b.  ____________ e.  ____________

c.  ____________ f. 

g.  ____________

3. Indicate the proper map shading, symbol, and color for the following weather features:

Feature	Shading	Shading Color	Symbol & Color
a. Snow shower	______	______	______
b. Fog	______	______	______
c. Continuous drizzle	______	______	______
d. Thunderstorms	______	______	______
e. Haze	______	______	______
f. Intermittent snow	______	______	______

4. Isobars are drawn and labeled in what color?

- a. Black
- b. Red
- c. Yellow
- d. Blue

5. Centers of high-pressure areas are marked by the

- a. word high in red
- b. word high in purple
- c. letter H in green
- d. letter H in blue

6. A TROUGH of low pressure is indicated by a dashed line of what color?

- a. Brown
- b. Purple
- c. Yellow
- d. Black

UNIT 5

METEOROLOGICAL OBSERVATION EQUIPMENT

FOREWARD

This unit introduces you to the Meteorological observation equipment used in taking surface observations (lesson 1), upper air observations (lesson 2), radar observations (lesson 3), and satellite observations (lesson 4).

UNIT 5—LESSON 1

SURFACE EQUIPMENT

OVERVIEW

Identify the surface observation equipment used in taking surface observations.

OUTLINE

Automatic Weather Station (AN/GMQ-29)

Wind Measuring Set (AN/UMQ-5)

Calculators, Computers, and Evaluators

Aneroid Barometers

Marine Barograph

Thermometers

Instrument Shelter (ML-41)

Rain Gages

Visibility Measuring Equipment

Cloud Height Measuring Equipment

Equipment Outage

Maintenance and Material Management

SURFACE EQUIPMENT

It is necessary as an Aerographer's Mate to have a knowledge of maintenance procedures for all meteorological equipment and instruments used in taking Surface Weather Observations.

Because of the complexity of the theory of operation, operation procedures, and preventive maintenance procedures, this lesson will cover only a brief description of the mechanical and electrical meteorological equipment used in taking surface observations. In addition, the shipboard Maintenance and Material Management (3-M) Systems, the Naval Aviation Maintenance Program (NAMP), and the Meteorological and Oceanographic Equipment Program (MOEP) are briefly introduced.

NOTE: For a complete description of the equipment refer to the appropriate technical manual.

Learning Objective: Identify the surface observation equipment used in taking surface observations.

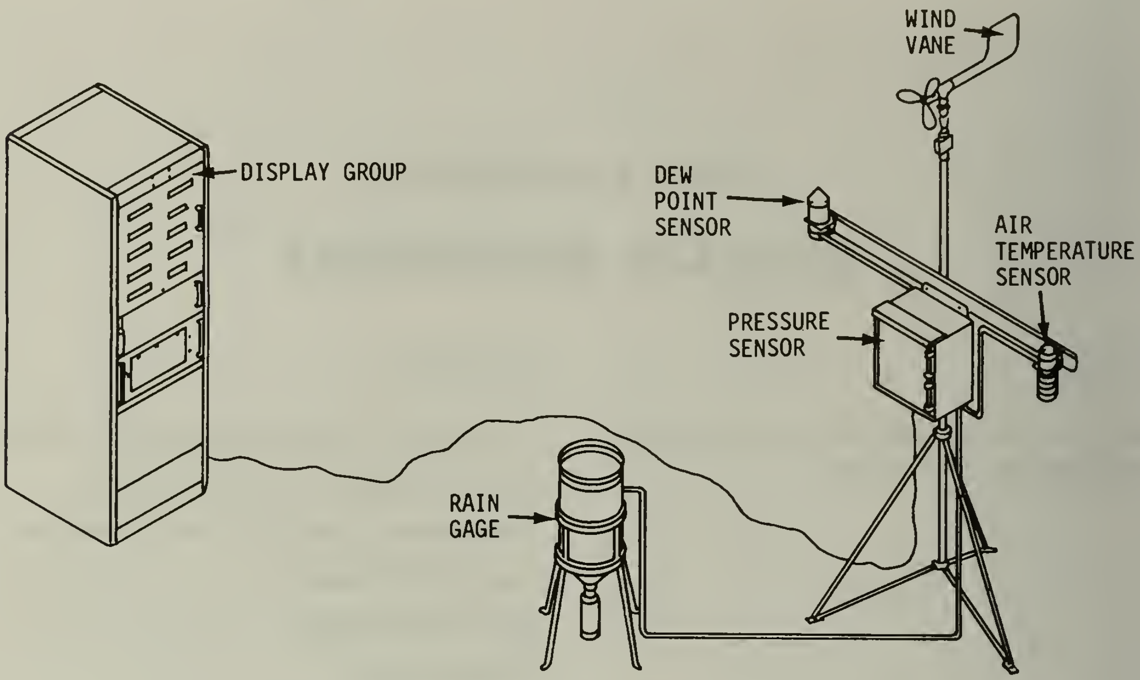

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Figure 5-1-1.—AN/GMQ-29( ) Automatic weather station.

AUTOMATIC WEATHER STATION

The automatic weather station AN/GMQ-29( ) (figure 5-1-1) accumulates and displays meteorological data for the support of air station operations and for use in forecasting. It is intended for installation at air stations where sensing equipment can measure weather conditions at or near the runway area.

The station consists of two major components. The first is the sensor group consisting of meteorological sensors and data transmission electronics. The second is the Converter Display Group (figure 5-1-2) consisting of data reception electronics, digital displays, and a chart recorder.

SENSOR GROUP

The sensor group (figure 5-1-1) consists of the air temperature sensor, pressure sensor, dew-point sensor, rainfall sensor, and the wind vane. The data gathered from the various sensors is transmitted over a single audio channel to the display unit inside the weather office.

Air Temperature Sensor ML-641/GMQ-29( )

The air temperature sensor (figure 5-1-3) consists of a resistance element probe mounted in an enclosure. This enclosure provides solar radiation shielding and protection from precipitation while permitting a free flow of air. The sensor is normally mounted within 15 feet of the transmitter.

Pressure Sensor ML-642/GMQ-29( )

Barometric pressure data is sent directly to its digital display.

Dew-Point Sensor ML-643/GMQ-29( )

The dew-point sensor is a heated resistance probe installed in a chamber which permits adequate self-aspiration while protecting the sensor from solar radiation, wind, and rain. Normal installation of the sensor is within 15 feet of the transmitter (shown in figure 5-1-4).

Rainfall Sensor ML-588/GMQ-14( )

The rainfall sensor consists of a tipping bucket mounted in a housing which permits rain to fall

209.394
Figure 5-1-2.—AN/GMQ-29( ) Converter display group.

209.395
Figure 5-1-3.—Air temperature sensor ML-641/GMQ-29( ).

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Figure 5-1-4.—Dew point sensor ML-643/GMQ-29( ).

209.401
Figure 5-1-5.—Tipping bucket rain gage, with door open showing the two-compartment tipping bucket on its pivot.

directly on the gage. The tipping bucket is a two-compartment container which pivots within a casting (shown in figure 5-1-5).

The rainfall enters through the upper funnel in the housing into one compartment of the bucket

until 0.01 inch of rainfall has accumulated. The weight of the rainwater unbalances the bucket, causing the unit to tip on its pivots, dumping the rainwater, and moving the other compartment under the funnel.

When the bucket tips, the rainwater falls into a funnel beneath the bucket. At the base of the funnel is a drain cock, which in its closed position permits the rainwater to collect so that it may be drained into the cylinder below the funnel at the time of measurement. If no purpose exists when measuring the rainwater at a given time, the drain cock may be left open and the cylinder removed.

The tipping motion of the bucket actuates a mercury switch in the casting. Momentary contact is established within the switch, causing an electrical impulse to be sent to the readout panel AN/GMQ-29( ).

The readout panel shows both a digital display and a recorded trace of rainfall. The tipping motion switch closures provide pulses to be counted and stored in the rainfall signal conditioner for each 0.01 inch of rainfall that occurs during the data frame (time period). The content of the counter is transferred to the display on command of the data transmitter. The contents are used to update the rainfall digital display and totalizer counter.

The amount of rainfall is recorded on the analog recorder RO-447/GMQ-29( ). It is recorded on the right side margin of the wind recorder chart and as an event marker to the left for each 0.01 inch of rain, with every tenth mark (0.01 inch) reversing direction and recording a mark to the right.

Wind Vane

The wind vane is part of the wind measuring set AN/UMQ-5( ) and will be covered separately later in this lesson.

CONVERSE DISPLAY GROUP

The converter display group (figure 5-1-2) consists of a data receiver and control assembly drawer, readout panel, and an analog recorder.

Data Receiver and Control Assembly

The data receiver and control assembly unit is contained in a slide-mounted drawer which provides access to all parts of the assembly from the front of the display unit. The display station power supply, electronic equipment for data reception and computations, and the control panel are contained within the drawer. Data electronic equipment is contained in a circuit card cage. A time-of-day clock module and an internal digital voltmeter are included in the assembly. The control panel, mounted just inside the drawer, has the provision for control of power, selection of system calibration, setting the time clock, resetting stored maximum and minimum temperatures and rainfall, and digital input and needed control (shown in figure 5-1-6).

Readout Panel

The readout panel contains digital displays for the time of day, temperature, dewpoint, maximum/minimum temperatures, pressure, rainfall, average wind speed and direction, and the digital voltmeter (figure 5-1-7). Each display consists of sufficient digital readout lamps to display the data.

Analog Recorder (RO-447/GMQ-29( ))

The analog recorder is mounted directly below the data receiver and control assembly. It

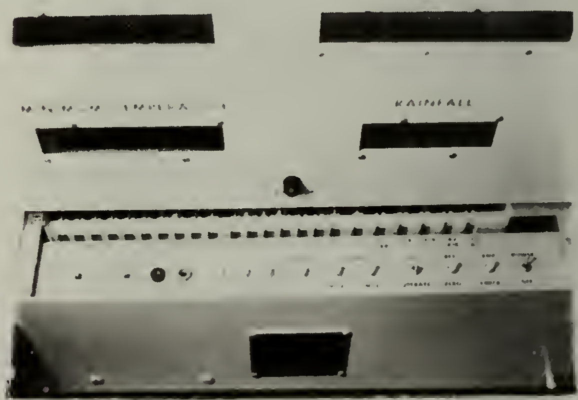

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Figure 5-1-6.—Data receiver and control assembly.

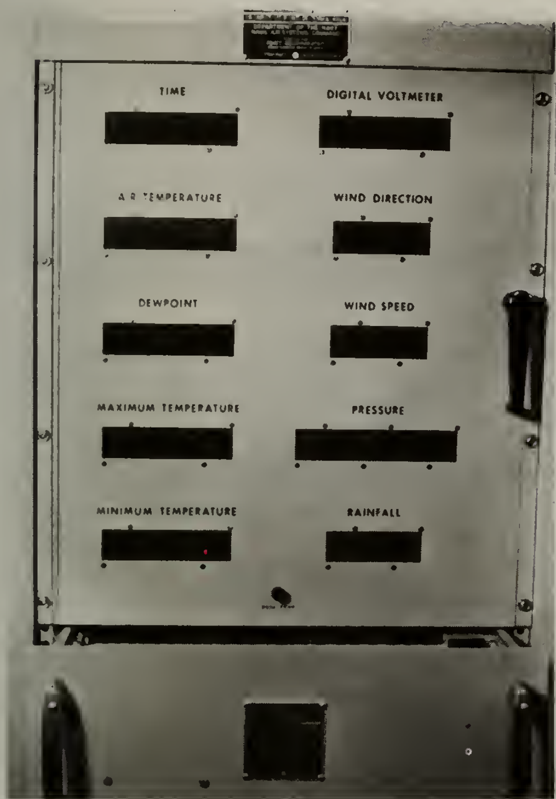

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Figure 5-1-7.—AN/GMQ-29( ) Readout panel.

is used to record wind direction, speed, and precipitation (shown in figure 5-1-8). The recorder uses the inputs from the UMQ-5( ) wind system.

NOTE: For a more detailed description of the automatic weather station AN/GMQ-29( ), refer to NAVAIR 50-30GMQ-29-1, *Handbook, Operation, Service and Overhaul Instruction*.

WIND RECORDER CHART

Chart identification is done at the beginning and end of each chart roll. The station name (NOCD, ADAK, ALASKA), date and time recording began/ended, and the chart feed rate, if different from normal or if times are not printed on the chart must be identified.

Charts must be changed at 0000 GMT on the first day of each month and at intermediate times as necessary to prevent loss of record.

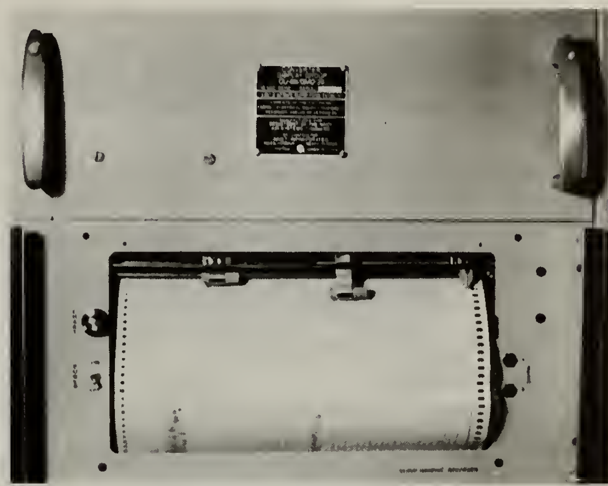

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Figure 5-1-8.—Analog Recorder RO-447/GMQ-29.

Time Checks

Time checks are made on the recorder chart of recording instruments by drawing a short line on the chart and entering the date/time to the nearest minute (GMT). As a minimum, time checks are required as follows:

1. At the beginning and end of each chart roll
2. At the approximate time of each 6-hourly observation
3. When notified of an aircraft mishap (except for barograph charts)
4. For each disruption or discontinuity in the trace—e.g., upon return of equipment to service following an outage or periodic maintenance
5. At the time of the first observation of the day at stations not operating 24 hours a day

Time Adjustments

Time adjustments must be made on a recorder chart to correct time whenever the time error is more than 5 minutes. An arrow must be drawn to the point of adjustment and the time entered near the arrow.

Annotations for Inoperative Periods

Maintenance shutdowns or other inoperative periods on the wind recorder must be indicated by entering time checks and date/time groups at the end of one period of operation and the beginning of the next. At the point of outage, enter appropriate reasons—e.g., POWER FAILURE, DETECTOR INOP, etc. When the equipment is returned to service, adjust the chart to the correct time as necessary. An appropriate entry should also be made in block 90 of MF1-10.

Chart Feed Rate

Whenever the chart feed rate is changed, enter a time check and an appropriate note—e.g., BEGIN 12 IN/HR, BEGIN 3 IN/HR, etc.

EXERCISE (5-1-1)

List the four sensors of the automatic weather station (AN/GMQ-29).

1. ____________

2. ____________

3. ____________

4. ____________

WIND MEASURING SET AN/UMQ-5( )

The wind measuring set AN/UMQ-5( ) is the standard equipment designed to provide a visual indication and/or printed record of wind direction and speed values (shown in figure 5-1-9). Various options of the system are provided to permit continuous recording of the wind direction and speed values at several measuring sites.

COMPONENTS

A AN/UMQ-5 set includes a minimum of one transmitter, one support, and one recorder or indicator. A maximum of six recorders and/or indicators can be used with each transmitter.

Although the complete wind measuring set is shown in figure 5-1-9, various options in mounting the display components of the set are shown in figure 5-1-10.

Transmitter ML-400( )/UMQ-5

The transmitter is a vane mounted on a vertical support (A) in figure 5-1-9. The tail of the vane brings the nose into the wind. The nose consists primarily of a screw-type impeller directly coupled to a tachometer magneto. The magneto voltage output is directly proportional to the wind speed and is connected to a transmitter. The indicator or recorder whose voltmeter automatically indicates or records the voltage (received from the transmitter) in knots. Motion of the vane (wind direction) is transmitted mechanically to a synchro located inside the enlarged section of the vertical support.

Support MT-535/UMQ-5

The support MT-535/UMQ-5 is of the tripod design, having an upright mast and three legs constructed of steel tubing (B) in figure 5-1-9. Each leg is equipped with a mounting foot. The top of the support is provided with a clamp to hold the transmitter securely in place when

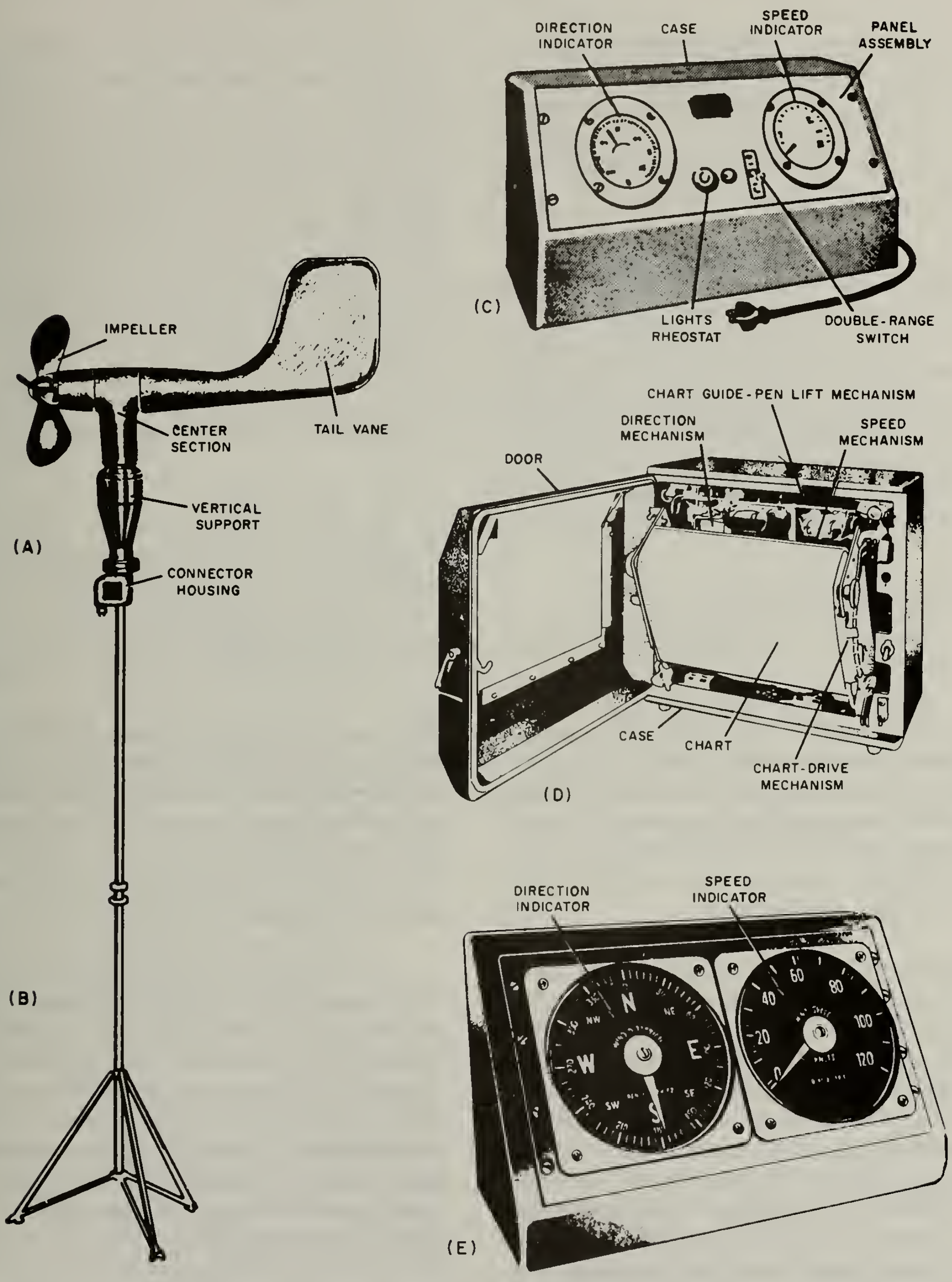

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Figure 5-1-9.—Wind Measuring Set AN/UMQ-5( ). (A) Transmitter ML-400( ); (B) Support MT-535; (C) Indicator ID-300( ); (D) Recorder RD-108( ); (E) Indicator ID586( ).

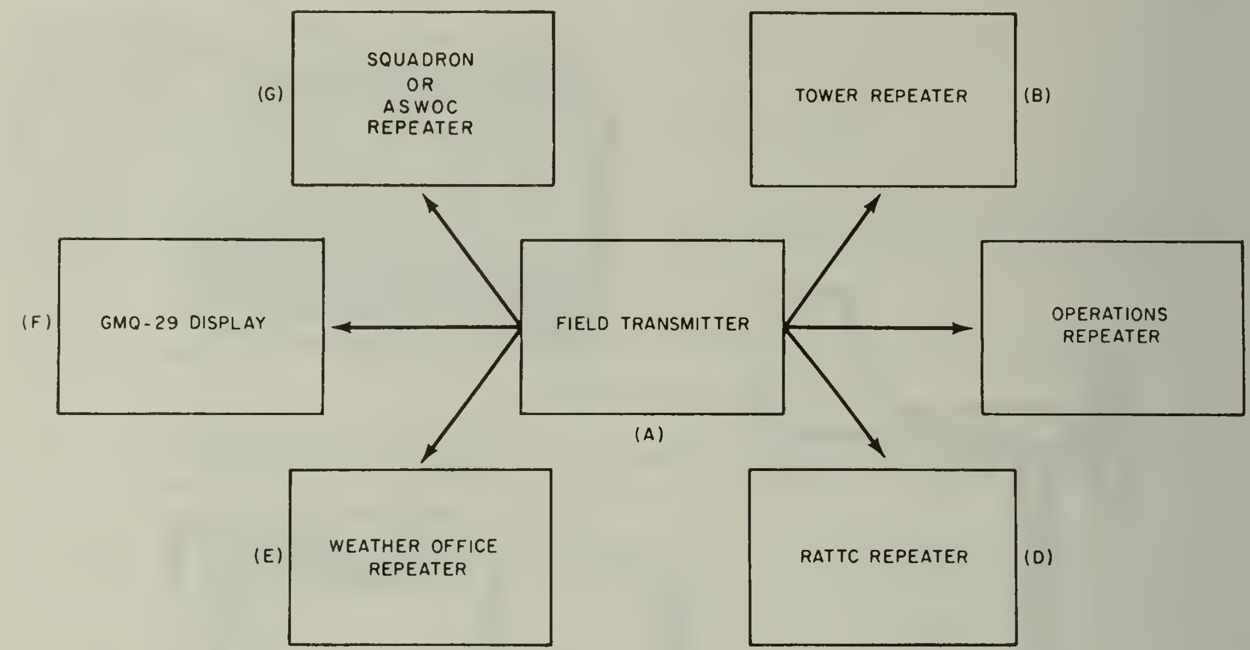

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Figure 5-1-10.—Display components mounting options.

mounted. Wires may be run through the center of the mast into the transmitter connector housing. The support may be tilted for servicing the transmitter. A guy plate is provided for the attachment of guy wires, if necessary.

Indicator ID-300( )/UMQ-5

The indicator ID-300( )/UMQ-5 consists of two units: the panel assembly and the mounting case which holds the panel assembly (C) in figure 5-1-9. The panel assembly contains the wind direction indicator and the wind speed indicator positioned in two 4-inch dials, the lighting circuits, and the double-range switch for the speed section. The wind direction indicator consists of a synchro follower on whose rotor shaft is mounted a pointer that indicates wind direction values on a 360-degree circular scale. The dial is graduated at the cardinal and intercardinal compass points as well as every 5 degrees from north. The wind speed indicator is a precision, high-shock voltmeter whose pointer indicates wind speed in knots on a scale whose ranges are 0 to 60 knots or 0 to 120 knots. The scales are circular about an arc of approximately 270 degrees. Selection of ranges is accomplished by the use of the double-range switch to change range from 0 to 60 knots to 0 to 120 knots.

Indicator ID-586/UMQ-5

The indicator ID-586/UMQ-5, (E) in figure 5-1-9, consists of a speed indicator (voltmeter) and a direction indicator (synchro) mounted on a panel which is inserted in a case. A six-tapped dummy load resistor is attached to the terminal board mounted in the bottom of the case. No panel lighting or dual-range circuits are installed in this indicator. Each of the indicating assemblies (speed and direction) is removable and may be installed individually.

Recorder RD-108( )/UMQ-5

The recorder RD-108( )/UMQ-5, (D) in figure 5-1-9, basically consists of a wind direction mechanism, wind speed mechanism, chart drive mechanism, chart guide-pen lift mechanisms,

chart, and case. This unit may be used as a backup for the recorder AN/GMQ-29.

WIND DIRECTION MECHANISM.—The wind direction mechanism consists of a synchro follower which positions the pen through a gear train which converts 540 wind degrees of synchro rotation to approximately 62 degrees of pen rotation, corresponding to 540 wind degrees of the chart. Whenever wind conditions are such that the pen runs off the chart in recording wind direction, a repositioning mechanism is energized. This mechanism removes power from the synchro; it drives the pen to the approximate center of the chart; it then returns power to the synchro so that recording is continued after the pen is displaced 360 wind degrees toward the middle of the chart.

The direction inking system consists of the pen and a stationary ink tank. The pen is designed to fit into a penholder attached to the synchro gear train and has a small tube which fits into the ink tank and feeds ink by capillary action to the penpoint which rests on the chart.

WIND SPEED MECHANISM.—The wind speed mechanism consists of a voltmeter mechanism which drives the wind speed pen across the speed section of the chart. Also included in the speed section is a six-tapped dummy load resistor connected across a terminal board. The pen and inking system of the speed section is identical to that of the direction section.

CHART DRIVE MECHANISM.—The chart drive mechanism is a removable, self-contained assembly consisting of a frame and various mounted parts. The assembly contains the chart drive motor, drive gear train, drive roll, idler roll, chart trough, removable takeup reel, takeup motor, and hinged panel. Also mounted on the assembly are the speed change gears, chart drive ON-OFF switch, takeup motor microswitch, and the plug through which power is introduced to the mechanism. When the mechanism is seated inside the recorder case and the chart drive switch is in the ON position, the chart drive motor moves the chart across the drive roll and under the pens at a rate determined by the change gears selected. The chart is rerolled on the takeup reel by the takeup motor.

CHART.—The strip chart is divided into two main channels. The right channel is for recording wind speed and is graduated every 2 knots from 0 to 120 knots. The left channel is for recording wind direction and is graduated every 10 degrees over a 540-degree range.

Direction letters representing the cardinal compass points (N-E-S-W-N-E-S) are printed above the appropriate numerical direction values. The chart is designed for use with the 3-inches-per-hour chart speed. The time lines are graduated to 10 minutes and numbered every hour. Holes on either side and in the center of the chart provide positive drive between the chart and the sprocket drive roll. The chart has a running time of approximately 15 days.

CALCULATORS, COMPUTERS, AND EVALUATORS

The important points in regard to calculators, computers, and evaluators are cleaning and storing them. The pointers listed in this section apply to all the computers in use in the Naval Oceanography Command. These include such items as the psychrometric computer, true wind computer, mixing ratio calculator, and the like.

To remove accumulations of dirt, dust, and lint from the spaces between the plates and under the cursor, draw a piece of paper through the space while applying a slight pressure to the disks or cursor. If grease or gummy deposits are present, moisten a blotter with soap and water and proceed as above. Exposed surfaces may be cleaned with a soft cloth, soap, and water. Rinse thoroughly and dry. DO NOT USE SOLVENTS.

Plastic calculators, computers, and evaluators should be returned to their original packaging preparatory for storage or shipment. If the original packaging is no longer available, an equivalent method will suffice. The items should not be stored in any atmosphere in which the temperature exceeds 140°F.

EXERCISE (5-1-2)

Write the missing words in statements 1 through 4.

1. **Wind measuring set (AN/GMQ-5( )) includes a minimum of one transmitter, one support, and one recorder or indicator. A maximum of__________recorder and/or indicators can be used with each transmitter.**

2. **The transmitter wind vane is directly coupled to a tachometer magneto. The magneto voltage output is directly proportional to the __________ __________.**

3. **The wind recorder (AN/GMQ-5) can record wind speeds up to and including__________knots.**

4. **Calculators, computers, and evaluators should not be stored in any area in which the temperature exceeds__________degrees.**

ANEROID BAROMETERS

The term "aneroid" means without fluid. The aneroid barometer is a fluidless barometer using the change in shape of an evacuated metal cell to measure variations in atmospheric pressure.

The aneroid barometer gets its name from the pressure-sensitive element used in the instrument. The aneroid is a thin-walled metal capsule or cell sometimes called a diaphragm, that has been either partially or completely evacuated of air. The aneroid barometer is usually made of beryllium copper or phosphor bronze. Most aneroid cells in the currently used aneroid barometers are self-supporting. They do not require external or internal springs to prevent crushing the cell walls by atmospheric pressure.

In a common type of single aneroid cell barometer (figure 5-1-11) the top of the evacuated cell is secured to a suitable linkage which transmits the motion of the aneroid to an index hand or pointer. This pointer indicates the pressure.

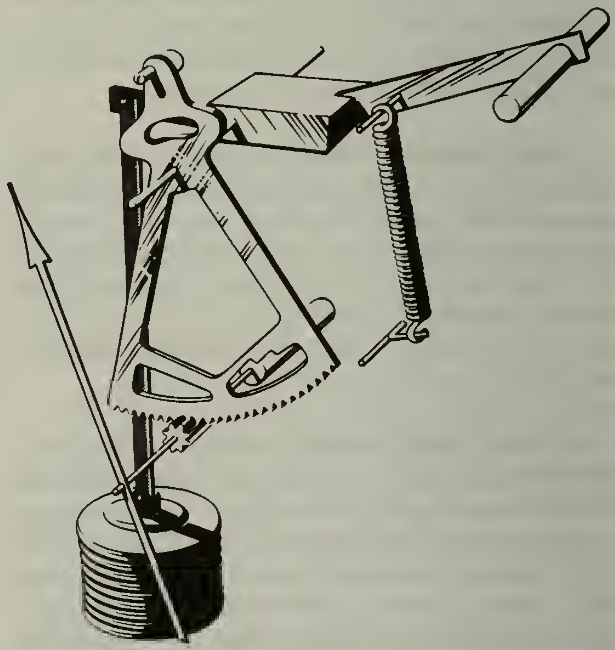

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Figure 5-1-11.—Simple diagram of the aneroid barometer.

PRECISION ANEROID BAROMETER (ML-448/UM)

The precision aneroid barometer (ML-448/UM), (figure 5-1-12) is used aboard ship and at land stations. The precision aneroid barometer is designed and manufactured to accurately indicate atmospheric pressure in millibars (mb) or inches of mercury.

The pressure element of the precision aneroid is a Sylphon cell which consists of a

209.93

Figure 5-1-12.—Precision aneroid barometer (ML-448/UM).

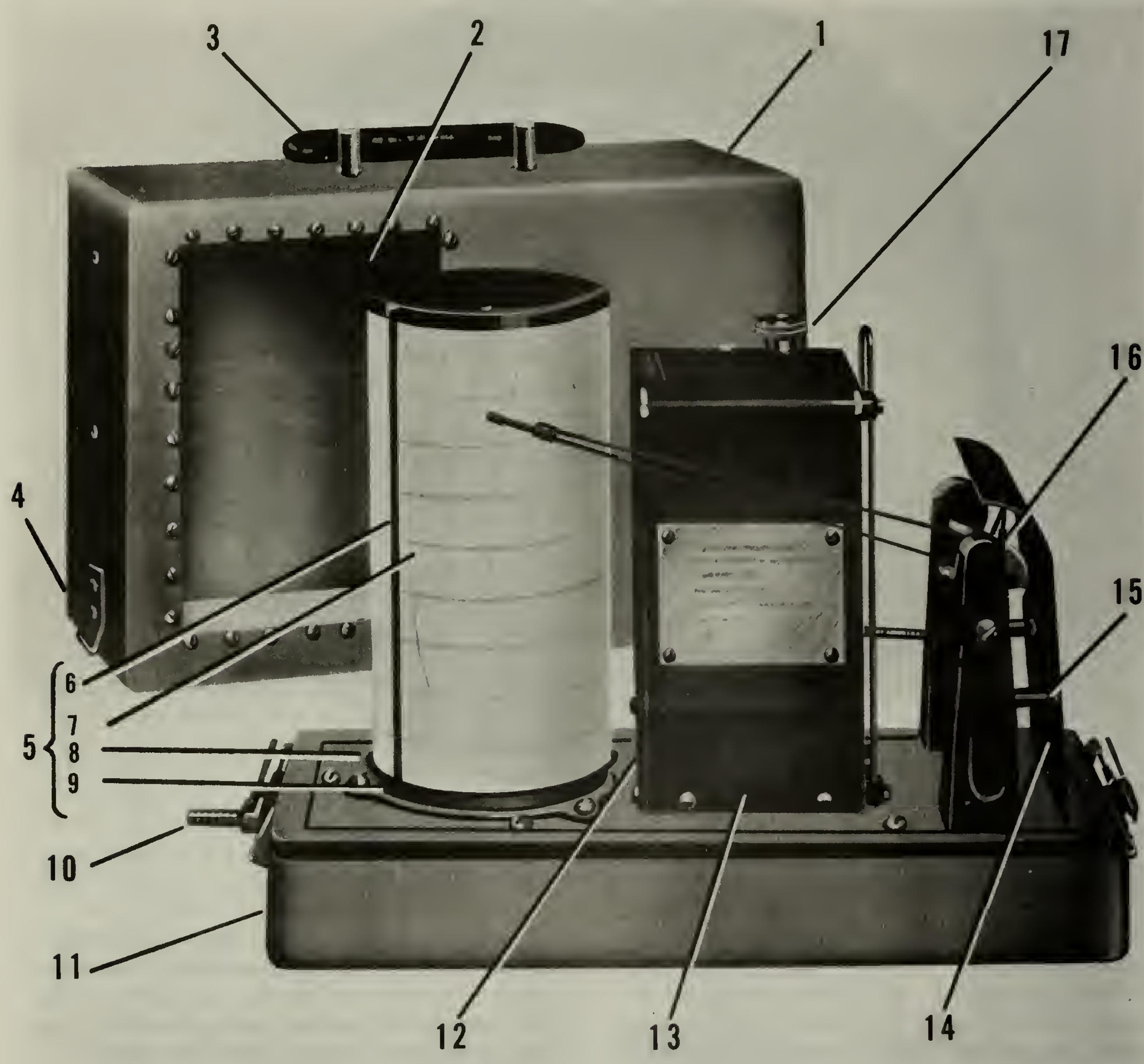
bellows-shaped metal cell having an internal spring to provide pressure calibration. This element is sensitive to minute variations in atmospheric pressure. The Sylphon cell is connected to an indicating pointer or index by means of a quadrant gear and lever system. In a given change in atmospheric pressure, the movement of the cell is greatly magnified by the linkage. This pressure variation is then transmitted to the index hand or pointer with a minimum of friction in the moving parts. The instrument has a range from 910 to 1060 mb and is accurate to 0.67 mb. Outside normal sea level pressure range, it is still accurate to within 1.0 mb.

The precision aneroid barometer is compensated for temperature changes; therefore, the indicated readings require no temperature corrections. Aneroid barometers use spring pressure to balance the effect of the air pressure on the Sylphon cell. Therefore, no corrections for effect of latitude (gravity) need be applied.

The pressure element, dial, and linkage are mounted on a sturdy metal frame that, in turn, is shock-spring suspended from the aneroid case. This spring suspension minimizes the effect of jars or shocks that would otherwise affect the linkage and index setting of the barometer.

MARINE BAROGRAPH

The purpose of the marine barograph (figure 5-1-13) is to register and record the atmospheric



1. Case.
2. Plastic sheet.
3. Handle.
4. Latch.
5. Chart drive assembly.
6. Chart clip.
7. Chart.
8. Chart cylinder.
9. Chart drive mechanism.
10. Hose connector.
11. Base.
12. Element assembly.
13. Element cover.
14. Mechanism shield.
15. Spacer.
16. Pen shaft assembly.
17. Adjustment knob.

209.94

Figure 5-1-13.—Marine barograph.

or barometric pressure. The magnified scale, high sensitivity, and accurate temperature compensation causes it to sometimes be referred to as a microbarograph. The instrument is designed to maintain its precision through the varied and exacting conditions encountered in marine use. Its recording is neither interrupted nor rendered inaccurate by pitch, roll, or vibration of the ship. An adjustable, grease-filled damping cylinder provides a means of preventing rise and fall of the ship from causing a corresponding wavy trace on this chart. The unit is quite portable and can record pressure either in its immediate vicinity or at some remote external point while located within a pressurized cabin system. It has a total usable range of 170 mb (915 to 1085 mb) over which it has been calibrated and temperature-compensated.

The airtight case locks to the base by means of two latches. When it is in place, a flexible rubber tube running to the hose connector from a remote source provides the means by which "outside" readings are recorded independently of the cabin pressure surrounding the instrument.

The chart drive assembly consists of a chart drive mechanism, a chart cylinder, a chart, and a chart clip. The chart drive mechanism is an 8-day, spring-wound clock with antibacklash gears and a self-contained lever for winding. The removable cylinder is driven at the rate of one revolution in 108 hours (4.5 days) through additional antibacklash gears. As a result, vibration and shock do not make the chart record irregularly as a result of play in the cylinder drive system. Inside the cylinder top is a knurled nut which permits removal of the cylinder for winding the clock. The chart (figure 5-1-14) is held in place by a chart clip.

OPERATION

This barograph needs very little attention. It records barometric pressure on a 108-hour chart and can be read at any time by interpolation to within one- to two-tenths of a millibar.

Winding and Chart Changing

The correct procedure for winding and changing the chart is as follows: Lift the pen

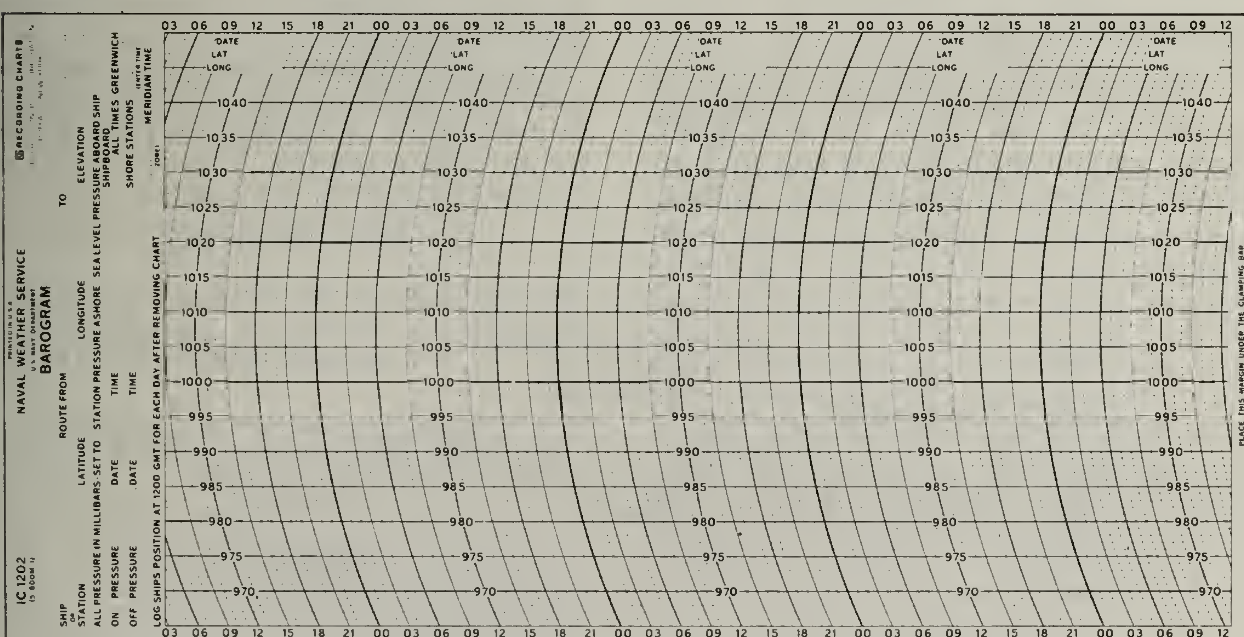


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Figure 5-1-14.—Blank barograph chart.

from the chart by means of the pen lifter and remove the cylinder. Every time a chart is changed, the clock should be wound; approximately eight pulls of the lever are enough. Wrap a chart around the cylinder so the tab end is covered and the chart is held in place firmly against the bottom flange of the cylinder and replace the chart clip. Install the cylinder carefully in place until the antibacklash gear teeth engage. By rotating the cylinder, set the pen to indicate the correct time. Check to see if the pen has sufficient ink (about one-half full), then lower the pen and replace the case. If the ink should fail to feed, reopen the case and draw a piece of glossy (bond) paper through the pen nibs to start the flow.

Pen and Ink

Very little ink is needed; a half-full pen should suffice. In fact, in damp weather the nib may appear to become fuller. This is because the instrument ink is hygroscopic and absorbs moisture. As this process continues, the trace becomes paler because of dilution. Wash and re-ink. A wide trace is caused by dust accumulated on the point or a dull or bent point.

Use Beyond Chart Range

The normal barograph chart has a range of 965 to 1,060 mb. When approaching any extreme pressure condition which may carry the pen off the chart, turn the adjustment knob to move the pen about 40 mb away from the close edge of the chart. When the condition is passed, reset by exactly the same amount and mark the affected portion of the chart accordingly.

BAROGRAPH CHARTS

Barograph charts (figure 5-1-14) should be handled in the following manner:

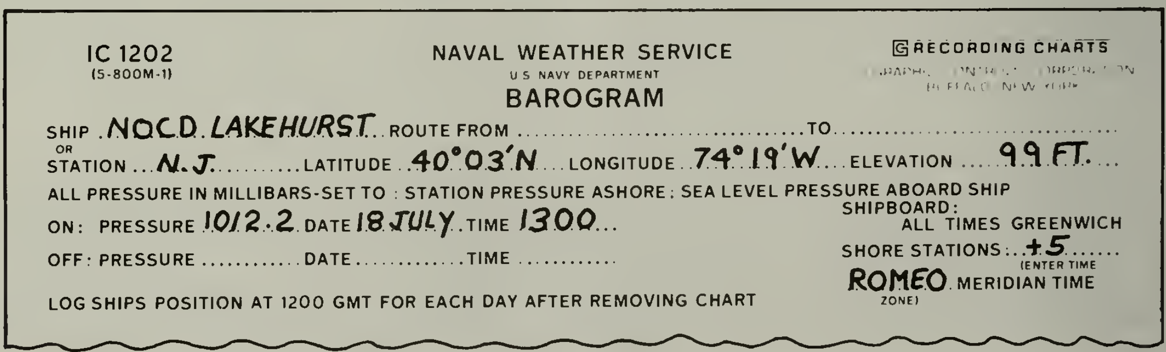
1. Before placing a chart on the barograph, use a typewriter, rubber stamp, or pen and ink to enter the following data:

a. In the spaces provided, enter the name of the station and its type (NAS, FWC, etc.) and elevation of the station (H_p) to the nearest foot. Where provision is not made for the H_p entry, identify the value with the prefix "H_p =." Aboard ship, enter the name of the ship and route "from-to."

b. In the spaces provided or above the appropriate noontime lines, enter the date of the beginning and ending of the trace.

c. Immediately preceding the printed figures along the first- and last-time arcs, enter the appropriate figures to indicate the chart range—e.g., 28 preceding the printed 00 on the 28-inch line (28.00).

d. In the spaces provided or near the point where the trace begins, enter "ON" and the time to the nearest minute GMT and the current station pressure. Figure 5-1-15 is an example of the above instructions.


IC 1202
(5-800M-1)
NAVAL WEATHER SERVICE
U S NAVY DEPARTMENT
BAROGRAM
RECORDING CHARTS
SHIP NOCD LAKEHURST ROUTE FROM .... TO ....
OR
STATION N.J. LATITUDE 40°03'N LONGITUDE 74°19'W ELEVATION 99 FT.
ALL PRESSURE IN MILLIBARS-SET TO : STATION PRESSURE ASHORE ; SEA LEVEL PRESSURE ABOARD SHIP
ON: PRESSURE 1012.2 DATE 18 JULY TIME 1300
OFF: PRESSURE .... DATE .... TIME ....
SHIPBOARD: ALL TIMES GREENWICH
SHORE STATIONS: +5 (ENTER TIME ZONE) ROMEO MERIDIAN TIME
LOG SHIPS POSITION AT 1200 GMT FOR EACH DAY AFTER REMOVING CHART

209.94.2

Figure 5-1-15.—Entries on barograph chart.

2. After adjustments or removal of a completed barograph chart, use the following procedure:

a. Enter the time of each adjustment and an arrow to indicate the point of adjustment.

b. In the spaces provided or near the end of the trace, enter "OFF" and the time to the nearest minute and the current station pressure.

c. Enter the appropriate corrections above the time-check lines. The pen of the marine barograph should be touched lightly at each six hourly GMT observation. The correction to the marine barograph reading is determined by comparing the corrected aneroid barometer reading with the micrograph reading. These corrections are entered at the corresponding points on the barogram after the latter has been removed from the cylinder.

d. When adjustment for pressure is made, enter in column 90 of the observation sheet, the time (GMT) and the statement—BAROGRAPH RESET TO ZERO.

3. Change the charts at 6-hourly times (0000, 0600 GMT, etc.) closest to noon LST on the 1st, 5th, 9th, etc., day of the month.

4. Barograph charts from land stations are forwarded to the Naval Oceanography Command Detachment, Asheville, N.C. Ships do not submit these chart records.

THERMOMETERS

Thermometers must be handled carefully to avoid breakage. In addition the following routine care should be observed:

- Keep the thermometer stem and bulb clean and free of dirt, dust, or salt spray. Clean by wiping with a soft rag.

- During rain or snow storms accompanied by high winds, the thermometer bulb may become wet. The presence of moisture on the bulb may cause it to indicate too low a temperature. If for any reason moisture is observed on the bulb, it should be wiped off carefully 10 to 15 minutes before a reading is to be taken.

- The metal back upon which the thermometer is mounted (especially aluminum backs) are frequently observed to be partially covered with numerous rough, gray spots. Remove and clean at least once every 3 months or more often if necessary. To clean, carefully remove the thermometer by unscrewing the four brass screws of the two securing straps. With the thermometer removed, clean the back with a soft cloth soaked in a solution of bicarbonate of soda (common baking soda). Under no circumstances should abrasives or acid be used in cleaning. Wash and dry thoroughly after cleaning. Upon reassembly the four brass screws used to hold the two securing straps should have a very minute drop of light oil applied to their threads.

- Frequently the black pigment in the etched graduations on the scale will wear out or fall out making reading difficult. To renew carefully clean and dry the thermometer and tube after you have removed it from the metal back. The older remaining pigment need not be removed. Then rub the stem or back (as the case may be) with a soft cloth saturated with a mixture of ivory black or lamp black mixed with varnish until the graduations are filled. Excess pigment can be removed by rubbing over the parts of the thermometer lightly with a swab of tissue paper. Reassemble as soon as dry and the instrument is as good as new.

- Broken mercury column.—Attach a psychrometer sling to the top of the back and whirl. When whirling has no effect use the heat method providing the mercury column is not too high in the tube. Heat the bulb gently, forcing the liquid into the space at the top of the tube until the entire column is united. To avoid breakage care must be taken to leave a small space at the top of the tube while heating. Allow the thermometer to cool and draw all the mercury back into the tube in a united column. If neither method works, survey and replace the thermometer. The readings are probably too much in error to obtain the required accuracy.

MAXIMUM THERMOMETER

The care of a maximum thermometer is generally the same as prescribed for the standard

thermometer. The following additional precautions must be observed:

1. The space in the bore not occupied by mercury is a nearly perfect vacuum. If the mercury column does not rest against the constriction before the operation of whirling is started incident to resetting, the violent throw-down of mercury may fracture the constriction and leave it much larger than it should be. When such an internal fracture occurs, it appears as an iridescent patch in the neighborhood of the constriction when the thermometer is examined in a reflected light. The instrument is then defective and it is said to be a "retreater."

2. In a "retreater" the constriction is so large that, as the temperature lowers, some of the mercury from the bore above retreats through the constriction into the bulb. Also, even with careful lowering of the instrument prior to reading, a "retreater" permits some of the mercury in the upper stem to pass through the constriction.

3. Obviously, accurate maximum temperatures cannot be obtained from such an instrument. As soon as a "retreater" is discovered, it should be replaced with a serviceable instrument.

MINIMUM THERMOMETER

The same general care is to be taken as is prescribed for the air thermometer. Rough handling, shocks, or jars may cause the alcohol column to break up into small sections. The following additional precautions must be observed:

1. Hold the thermometer with the right hand in a vertical position, bulb end down. Tap lightly against the heel or fleshy part of the left hand. This action usually serves to reunite the broken segments of alcohol. Care must be taken not to break the tip on thermometer tube by using excessive force.

2. If this method fails, attach the thermometer to a psychrometer sling and whirl.

3. If the alcohol column is not reunited by either of the above methods, the only recourse is to declass the instrument as unfit for service.

ELECTRIC PSYCHROMETER (ML-450A/UM)

The operations of the ML-450A/UM was covered in unit 1, lesson 3 of this manual.

Batteries

Three size D (standard flashlight) dry cell batteries are required. To insert the batteries, remove the sliding door at the end of the case and rotate the spring contact from the battery compartment to the bottle compartment.

The batteries must be inserted so that the center contact enters the compartment first. After the batteries are in place, rotate the spring contact to its original position on the end battery and replace the sliding door.

When the instrument is not to be used for a prolonged period of time, remove the batteries from the case because batteries will corrode and damage the instrument.

Replacing the Wick

To replace the wick, first remove the sliding air intake exposing the thermometer bulbs. Next remove the wick. Slip a length of wicking over the bulb. Secure at the top of the bulb with a thread at the constriction between the bulb and the stem using a loop and square knot. Form a loop in a second thread and place it at about the middle of the bulb; stretch the wick firmly and snugly against the bulb. Tie with a double loop and square knot at the end of the bulb. Clip the ends of the thread and cut off the excess wicking about 1/8 inch below the bottom of the bulb.

Removing and Replacing Thermometers

If either thermometer is damaged, it is necessary to remove both thermometers and replace with a matched pair. To remove and replace the thermometers, first remove the air intake and the thermometer retainers. Next lift out the thermometers. Remove the rubber bushings from the bulb ends of the thermometers and the bushings from the other ends of the thermometers.

Place the longer bushings on the bulb end of the new thermometers so they are flush with the

end of the thermometer holder. This seals the small holes in the air intake when you slide it into position.

CAUTION: Position the rubber bushings on the thermometer so the retaining clamps rest on them. If this is not done, the pressure of the retaining clamps may break the thermometers.

Replace the thermometers, positioning them so the graduations are visible and both mercury columns are magnified when viewed from the same position. Replace and tighten the thermometer retaining clamps.

TOWNSEND SUPPORT (ML-54)

The Townsend support (figure 5-1-16) is used to provide a suitable mounting for the maximum and minimum thermometers in the instrument shelter. A means is provided also for resetting the thermometers without removing them from the support. With the base plate in a vertical position, the support is mounted with the top and bottom sides in a true horizontal line. It is necessary that the Townsend support be mounted in such a position that the maximum thermometer has a clear area of rotation when being reset and the thermometer bulbs are at least 3 inches away from other objects in the instrument shelter.

The only care required for the Townsend support is an occasional drop of oil (about one drop per month) in the oilholes at the base of the studs and occasional cleaning of the metal surfaces with a soft cloth soaked in a solution of bicarbonate of soda and water. Wash and dry thoroughly. Check to ensure that the thumbscrew securing the maximum thermometer is finger-taut before whirling.

INSTRUMENT SHELTER (ML-41)

With the increased use of automatic weather stations, such as the AN/GMQ-29( ) that have

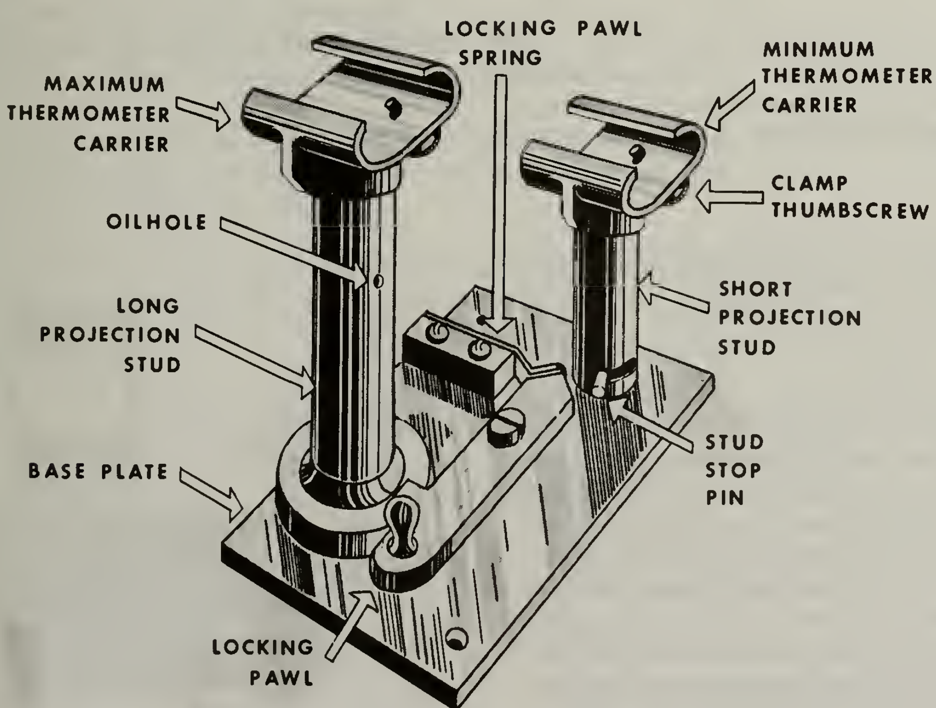


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Figure 5-1-16.—Townsend support.

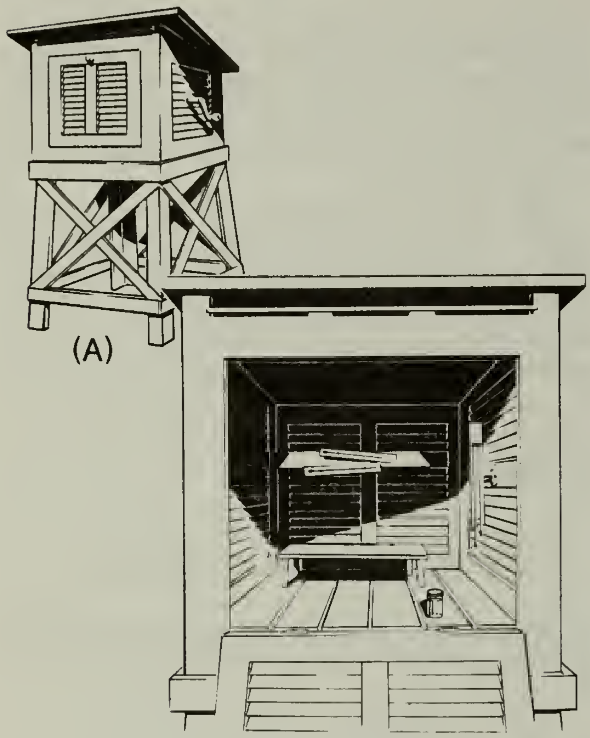

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Figure 5-1-17.—Standard instrument shelter. (A) construction of support; (B) instrument arrangement inside the shelter.

self-contained shelters for their sensing elements. The wooden-type shelters (figure 5-1-17) are becoming a thing of the past. However, it is the opinion of this author that the shelters should be maintained as backups.

The instrument shelter consists of a large wooden box fitted with a sloping double roof, louvered sides, and slotted door which is hinged to swing forward and down. This device is shown in figure 5-1-17. Construction of the shelter permits the air to circulate through it with the greatest possible freedom, while at the same time the instruments are protected from precipitation and the direct rays of the sun. Instrument shelters are constructed of wood (a poor conductor of heat) and are painted white (both inside and out) since a white surface is an excellent reflector of radiation.

The location of the shelter is important. It should be located at a minimum of 4 feet above a large, flat surface, preferably grassy and at least 10 feet from bulkheads, buildings, or other vertical surfaces. When the shelter cannot be mounted above a grassy surface, there should be a wooden grate between the surface and the floor of the shelter. The shelter faces north in the Northern Hemisphere and south in the Southern Hemisphere so that the sun never shines directly on the instruments in the shelter when the door is opened.

Instruments located in the shelter usually include the psychrometer and the maximum and minimum thermometers (mounted on the Townsend support).

RAIN GAGES

Precipitation measurements are made from samples caught in gages or from samples taken from representative areas when the catch of solid forms in the gage is not representative.

FOUR-INCH GAGE

The nonrecording plastic rain gage (figure 5-1-18) consists of a 4-inch (diameter) collector

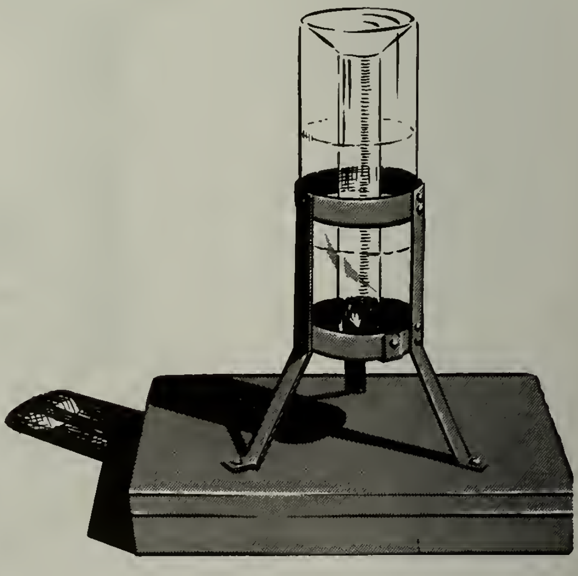

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Figure 5-1-18.—Standard 4-inch rain gage (ML-217).

ring and funnel which fit over the top of a tripod-mounted overflow container and a clear plastic measuring tube. The rainfall drains from the collector ring through the funnel into the measuring tube. The measuring tube has graduations in the wall for direct reading to the nearest hundredth of an inch.

The only maintenance required for the standard 4-inch rain gage is to keep it clean at all times and make sure it is mounted firmly.

EXERCISE (5-1-3)

Write the missing words in statements 1 through 8.

1. **The precision aneroid barometer ML-448/UM has a pressure range from __________ to __________ millibars.**

2. **Every time a chart is changed on the marine barograph, the clock should be wound by pulling the lever approximately __________ pulls.**

3. **The marine barograph chart should be changed on the first of each month at a synoptic time closest to noon LST and every __________ day thereafter.**

4. **The thermometer's stem and bulb should be clean and free of dirt, dust, or salt spray. Cleaning can be done by wiping with a __________ __________.**

5. **When the hand electric psychrometer ML-450A/UM is not to be used for a prolonged period of time, remove the __________.**

6. **When mounting the Townsend support in the instrument shelter, make sure that the thermometer bulbs are at least __________ inches from other objects.**

7. **So that the sun never shines directly on the instruments in the instrument shelter, the shelter door should be facing the __________ in the Northern Hemisphere.**

8. **When using the 4-inch rain gage, precipitation measurements are taken from the measuring tube. It has graduations in the wall for direct reading to the nearest __________ of an inch.**

VISIBILITY MEASURING EQUIPMENT

The transmissometer AN/GMQ-10 is the only type of visibility measuring equipment used by new aerographers today. It provides sector visibility (direction of the AN/GMQ-10) and runway visual range.

TRANSMISSOMETER AN/GMQ-10( )

Transmissometer set AN/GMQ-10( ) is an electronic instrument which provides a continuous record of the atmospheric transmission between two fixed points (figure 5-1-19). The horizontal visibility may be determined by the application of conversions to these measurements. The

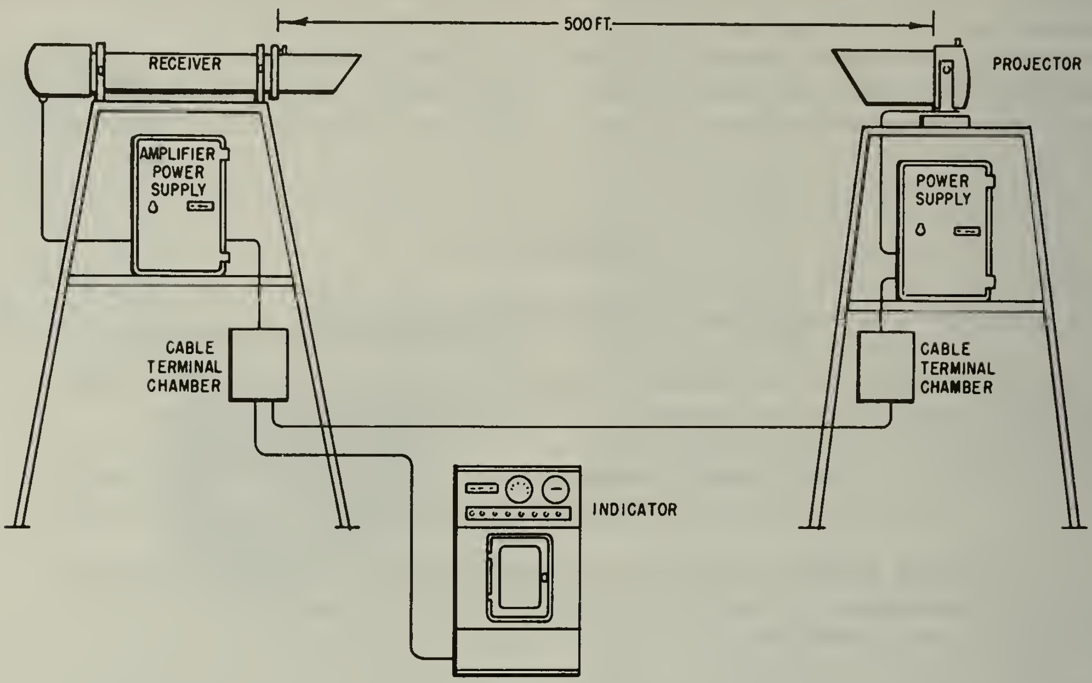

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Figure 5-1-19.—Typical installation of transmissometer AN/GMQ-10( ).

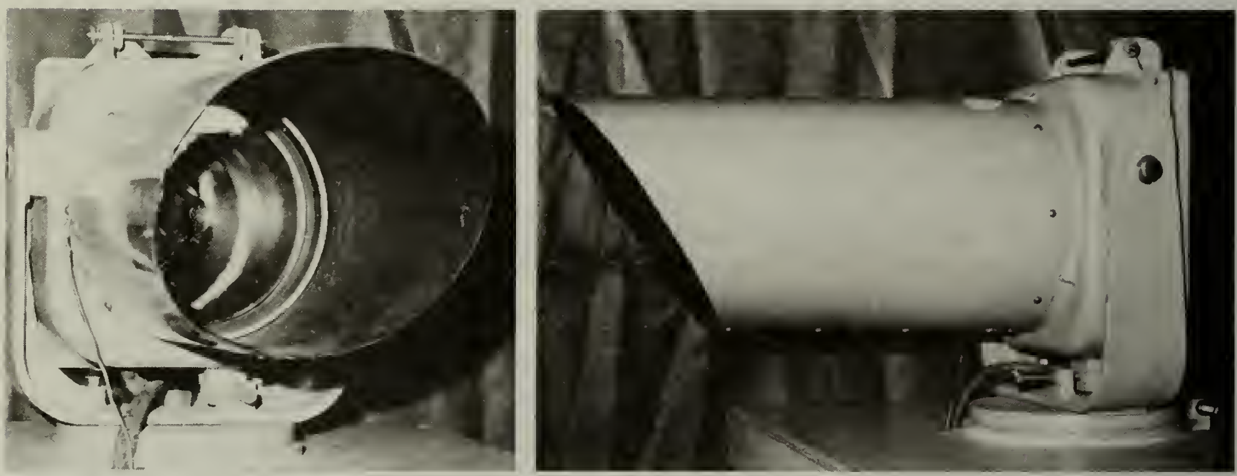

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Figure 5-1-20.—Projector transmissometer ML-471/GMQ-10( ) front and side views.

operation of the transmissometer is nearly automatic. It requires only the occasional attention of an operator to make minor adjustments.

The transmissometer is designed to provide visibilities in the range of 0.05 to 2 miles in the daytime and 0.1 to 2 miles in the nighttime when a 500-foot baseline is used. For visibilities greater than these, the indication is generally good but the accuracy of the visibility measurements decreases with increasing visibility.

Components

The transmissometer set may be conveniently divided into the following systems. Each of these systems is constructed as a separate unit.

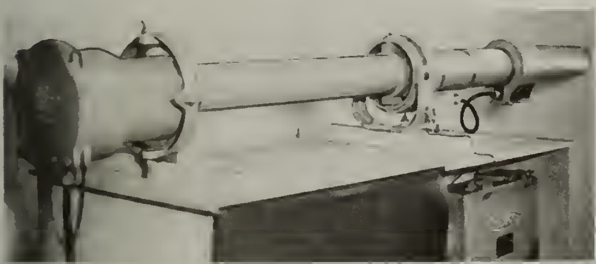

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Figure 5-1-21.—Receiver, transmissometer R-970/GMQ-10( ).

PROJECTOR.—The projector (figure 5-1-20) consists of an alignment system and a sealed-reflector lamp operated at a constant intensity. The projector directs a light beam of constant intensity toward the receiver. The amount of light reaching the receiver varies with the density of the fog or haze in the path between these two instruments.

RECEIVER.—The receiver (figure 5-1-21) has a telescope to collect light from the projector. A photoelectric detector within the telescope generates a pulse signal. At the same time the receiver excludes most of the light from the background. The pulse rate is proportional to the amount of light falling on the receiver.

INDICATOR.—The indicator (figure 5-1-22) is essentially a frequency meter which converts the pulse signal to a direct current which is

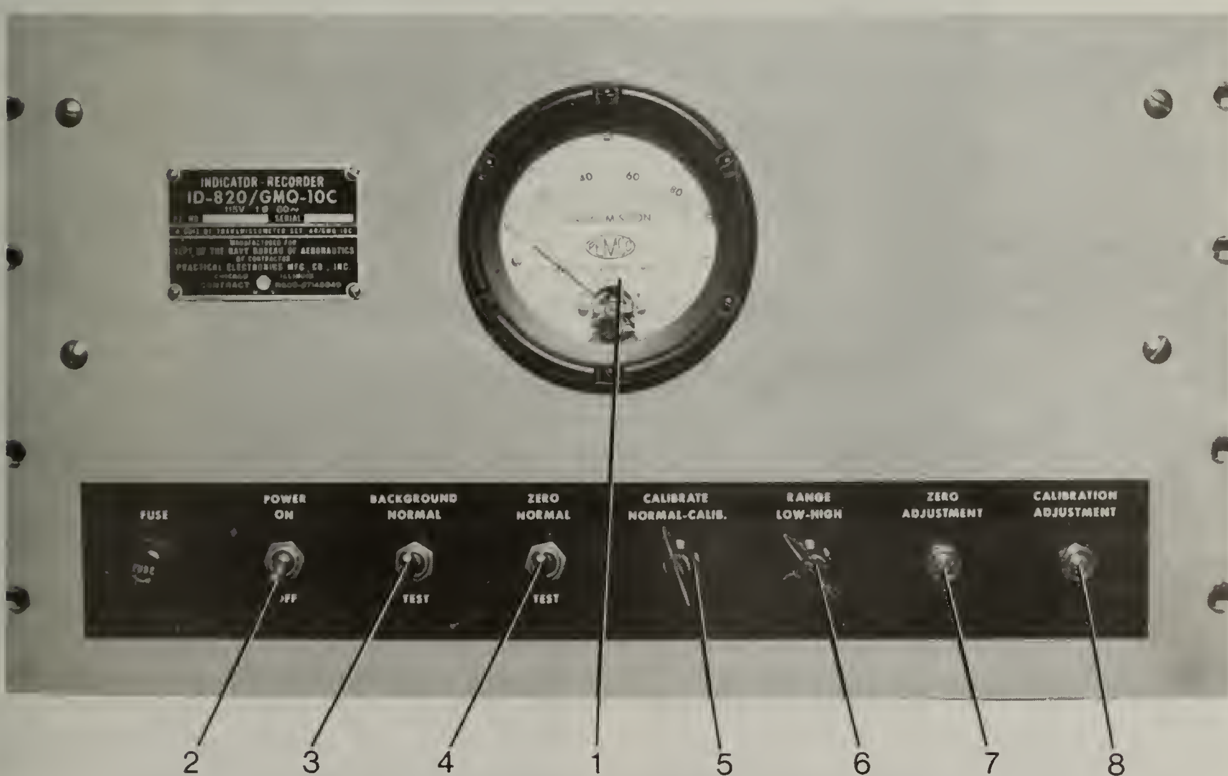

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Figure 5-1-22.—Transmissometer indicator control panel.

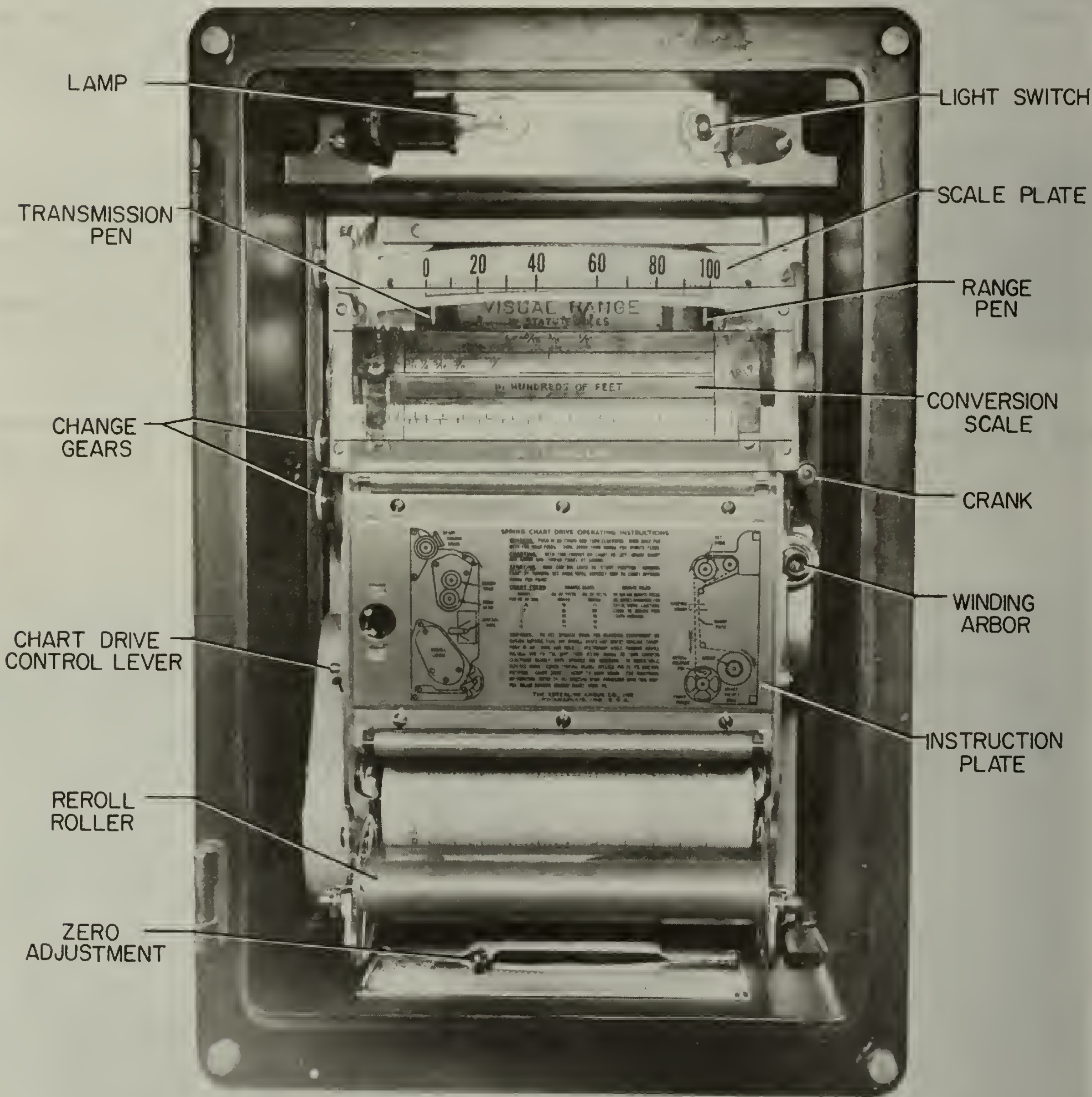

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Figure 5-1-23.—Transmissometer recorder with door open.

proportional to the pulse rate and hence to the transmission.

RECORDER.—On a strip chart the recorder (figure 5-1-23) provides a continuous record of the output of the indicator.

In all transmissometer AN/GMQ-10( ) modules the indicator and recorder are housed in a single unit known as the indicator-recorder.

Recording Charts (AN/GMQ-10( ))

The transmissometer recording charts should be handled in the following manner:

- Place station name, time check, date-time group (GMT), runway number and length of transmissometer baseline at the beginning and ending of each chart.

- Enter a time check and date-time group (GMT) at the actual time of each 6-hourly observation.

- Indicate maintenance shutdowns or other periods of nonoperation by inscribing time checks and date-time groups at the end of one period of operation and beginning of the next.

- Enter a time check and date-time group near the trace whenever notified of an aircraft mishap at or in the vicinity of the station.

- Adjust the chart to the correct time whenever the time error is 5 minutes or more and note the time of adjustment and a new time check on the recorder chart.

- When the transmissometer recorder roll has been exhausted, it should be placed in the empty chart carton. The station name as well as the dates for beginning and ending of roll and runway identification should be entered on the carbon. The used roll is retained as prescribed by local instructions.

CONVERTER-INDICATOR GROUP (RVR)

The runway visual range (RVR) is a measurement of the visibility along the runway through the use of converter-indicator group OA-7900A/GMQ-10 in conjunction with the transmissometer AN/GMQ-10. RVV is an instrumentally derived value that represents the horizontal distance a pilot can see down the runway from the approach end. Even though the equipment is termed RVR converter, it is used to obtain RVV and not RVR.

The converter-indicator group OA-7900A/GMQ-10 consists of signal data converter CV-3125/GMQ-10 and digital display indicator ID-1939/GMQ-10 as shown in figure 5-1-24.

RVV Theory of Operation

The RVV uses data from the transmissometer AN/GMQ-10 for the computation of visibility (RVV). The transmissometer supplies light transmittance signals in the form of pulse rates. These pulse rates are transmitted to the RVR converter where they are correlated with the empirically obtained visibility data encoded therein. The corresponding visibility value is then displayed once every minute.

The system is designed to convert the transmittance pulse rates to their corresponding visibility values with a high degree of accuracy. They are based on a 500-foot baseline between the transmissometer projector and receiver.

The visibility system converts the pulse rates from the transmissometer sets of other baselines provided the visibility values to be displayed are properly related to the pulse rates, and encoded on the encoder disk.

The visibility values are displayed digitally in increments of 200 feet ranging from 1,000 to 6,000 feet. Values less than 1,000 and greater than 6,000 feet are displayed as 800 feet and 6,200 feet respectively. Actually, the values are displayed as two-digit numbers which should be multiplied by a factor of 100 in order to obtain the correct reading. When the equipment is tested or the runway lights are OFF, the red light indicator on the display panel is ON. Consequently, the displayed values should not be accepted as true values of RVR.

CLOUD HEIGHT MEASURING EQUIPMENT

The accurate determination of cloud heights is a difficult problem to solve under all conditions. To aid in obtaining these determinations, several types of equipment have been devised. Some are capable of night determination only, while others provide capability for both day and night

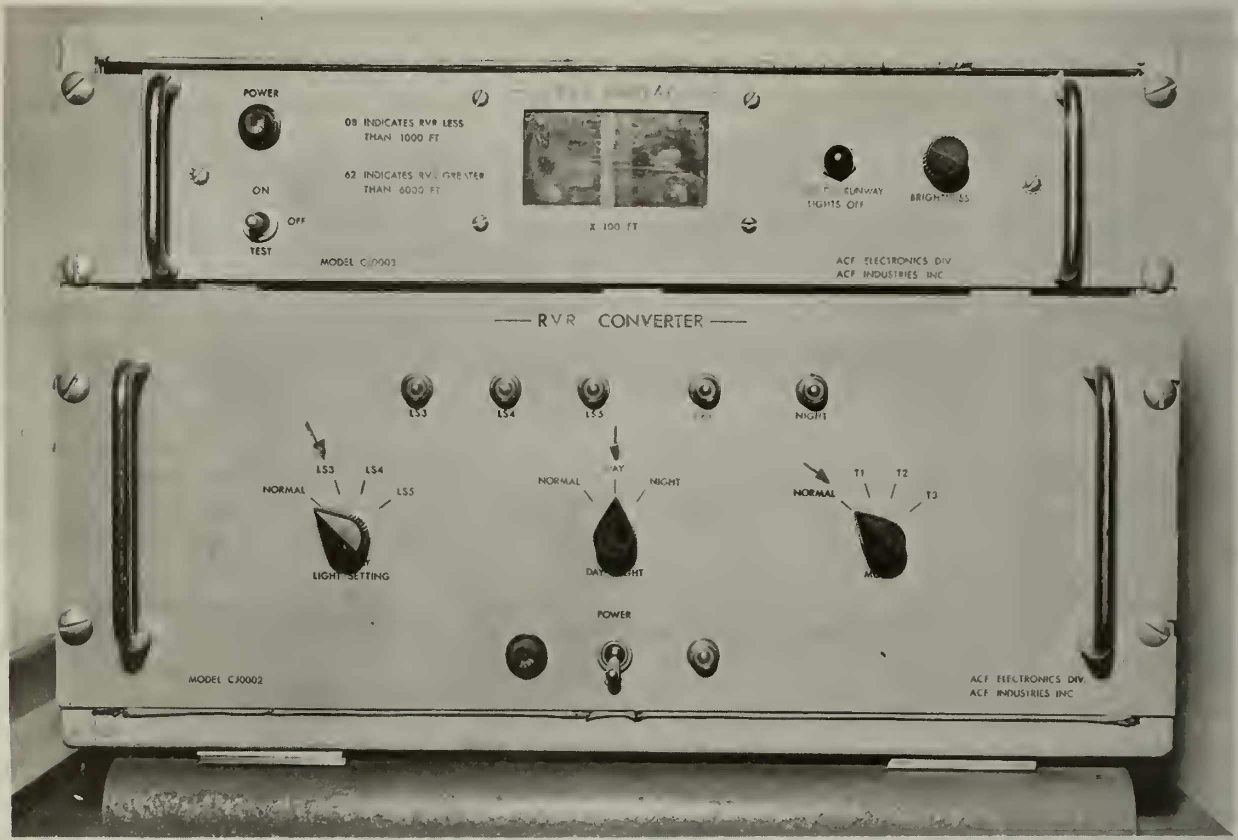

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Figure 5-1-24.—Converter-indicator group OA-7900A/GMQ-10.

observations. The following paragraphs describe these equipments and their operations.

CEILING LIGHT PROJECTOR ML-121

The ceiling light projector ML-121 (figure 5-1-25) consists of a drum and an optical system. The drum is a weatherproof, one-piece casting which holds the various parts of the projector in their correct positions. Leveling perches (90 degrees apart), are adjusted so that the beam is directed at the zenith when both perches are level.

The optical system consists of the lamp, primary reflector, secondary reflector, socket assembly, supporting base, and transformer.

The primary reflector is a parabolic mirror constructed of silvered, high-transmission glass. The secondary reflector is a spherical, silvered glass mirror. Neither of these crack when subjected to repeated heating and cooling cycles.

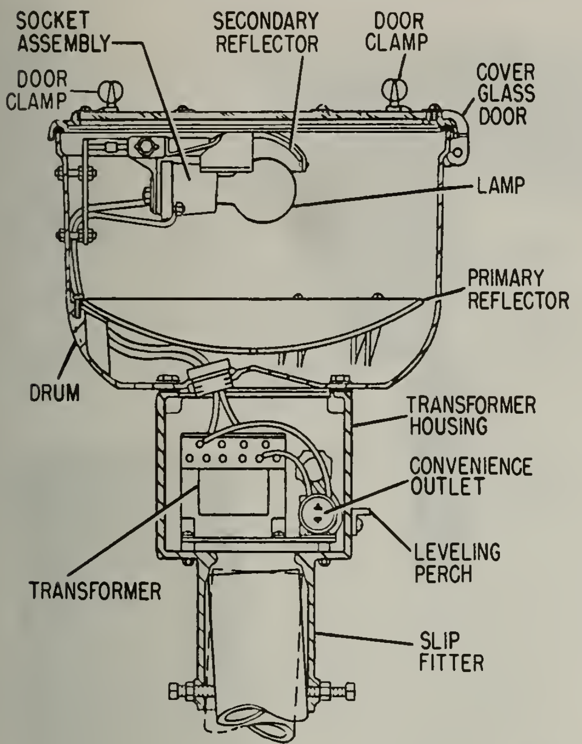
The secondary reflector is held in a spherical reflector holder which is rigidly mounted on an arm of the socket assembly so that the focal points of the reflector and lamp coincide.

The socket assembly consists of a cast aluminum or iron base and is located so that it supports the lamp at the focal point of the secondary reflector.

The base of the projector is a single casting for both the transformer housing and slip fitter. The slip fitter is designed to fit over a 4-inch standard pipe with sufficient play to permit leveling of the drum by four setscrews.

Operation

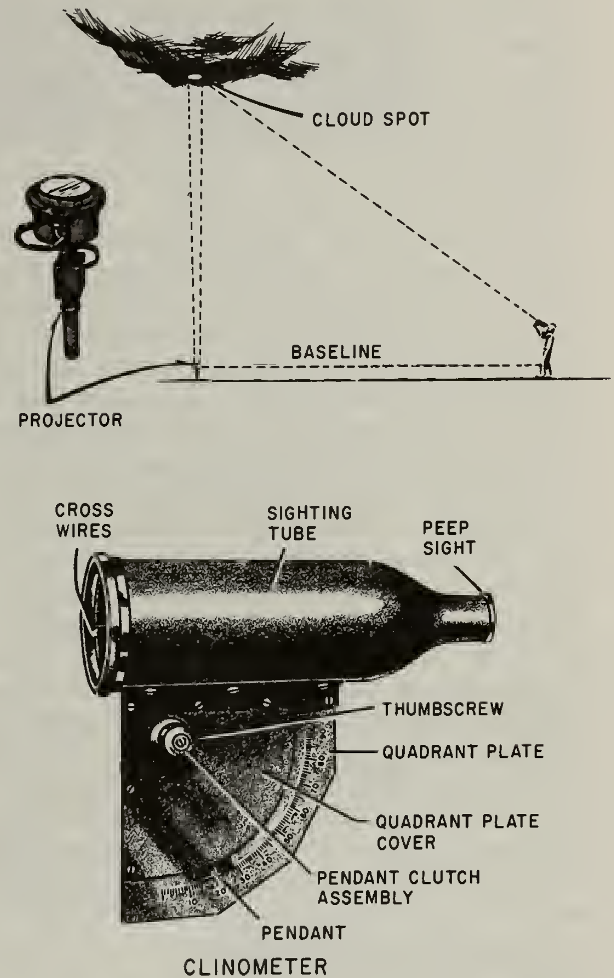
The ceiling light projector should be installed so that a standard baseline (horizontal distance from the projector to observation point) near



209.110
Figure 5-1-25.—Ceiling light projector ML-121 detail.

800 feet can be established and so that supplementary baselines near 400 and 1,600 feet can be marked when practicable. The 400-foot baseline is for use when clouds are below 500 feet; the 1,600-foot baseline is for use when clouds are above 10,000 feet.

It is not necessary for the observation point and the projector to be at the same level when the clinometer is used. The control switch should be convenient to the observation point, so that the light need not be turned on for a period of time longer than required to obtain an observation. Since the ceiling light projector is generally close to the field, never leave it on any longer than necessary. The powerful light could blind night-flying pilots during a field approach. When at all practicable, the line of sight should be from south to north in order to avoid the occasional inconvenience due to moonlight on thin cloud patches. The projector must be carefully leveled. The level must be checked frequently to ensure a true vertical light beam. The lamp should be focused so as to throw a narrow, concentrated shaft of light.



209.111
Figure 5-1-26.—Ceiling light projector and clinometer ML-119.

CLINOMETER ML-119 (SHORE TYPE)

The Clinometer ML-119 (figure 5-1-26) is the portable hand instrument used to measure the angular elevation of a projected light "spot" on the base of a cloud. The clinometer has a sighting tube nearly 3 inches in diameter at its outer end. This size is necessary so that the light spot on the cloud as well as a portion of the surrounding dark sky may be included for contrast in the field of view. A pair of cross wires aid the eye in centering on the light spot. A quadrant with a scale from 0 to 90 degrees (in whole-degree graduations) is

rigidly attached to the underside of the tube. A weighted pendant is pivoted so as to hang vertically of its own weight when the tube is sighted on an object. The reference line on the pendant coincides with the 90 degrees line on the quadrant when it is sighted on the zenith. A clutch, operated with the left hand by means of a milled head thumbscrew, clamps the pendant in position when a sight is made.

To determine the cloud height, loosen the pointer thumbscrew. Sight the clinometer with the cross wires centered upon the lower part of the most clearly defined light spot on the cloud; tighten the clutch by means of the thumbscrew. Read the elevation angle to the nearest whole degree from the quadrant. The average elevation angle obtained by three sightings should be used to obtain the cloud height. Simple triangulation then enables the cloud height to be computed by using the known horizontal distance from the observer to the projector as a baseline. The height in feet equals the distance (length of the baseline in feet) multiplied by the natural tangent of the elevation angle. The height so determined is the height of the cloud above the observer. This height must then be corrected by an amount equal to the difference in elevation of the point of observation and the field elevation or ground. For convenience, a table of heights plotted against observed elevation angles should be made up for use of the observer.

209.112

Figure 5-1-27.—Clinometer ML-591/U (shipboard type) with cover.

CLINOMETER ML-591/U (SHIPBOARD TYPE)

This clinometer (figure 5-1-27) is designed for shipboard use only. It is used for measuring the elevation angle of a spot of light thrown on the base of a cloud by a ceiling light projector or searchlight in the same manner as the ML-119 previously mentioned, with minor exceptions. Usually this instrument is permanently mounted and only requires periodic orientation.

CLOUD HEIGHT SET AN/GMQ-13( )

The cloud height set is used on relatively short baselines of 400 to 900 feet, with the result that the highest accurate value of the cloud height measurement is approximately 5,000 feet. The standard baseline is 400 feet.

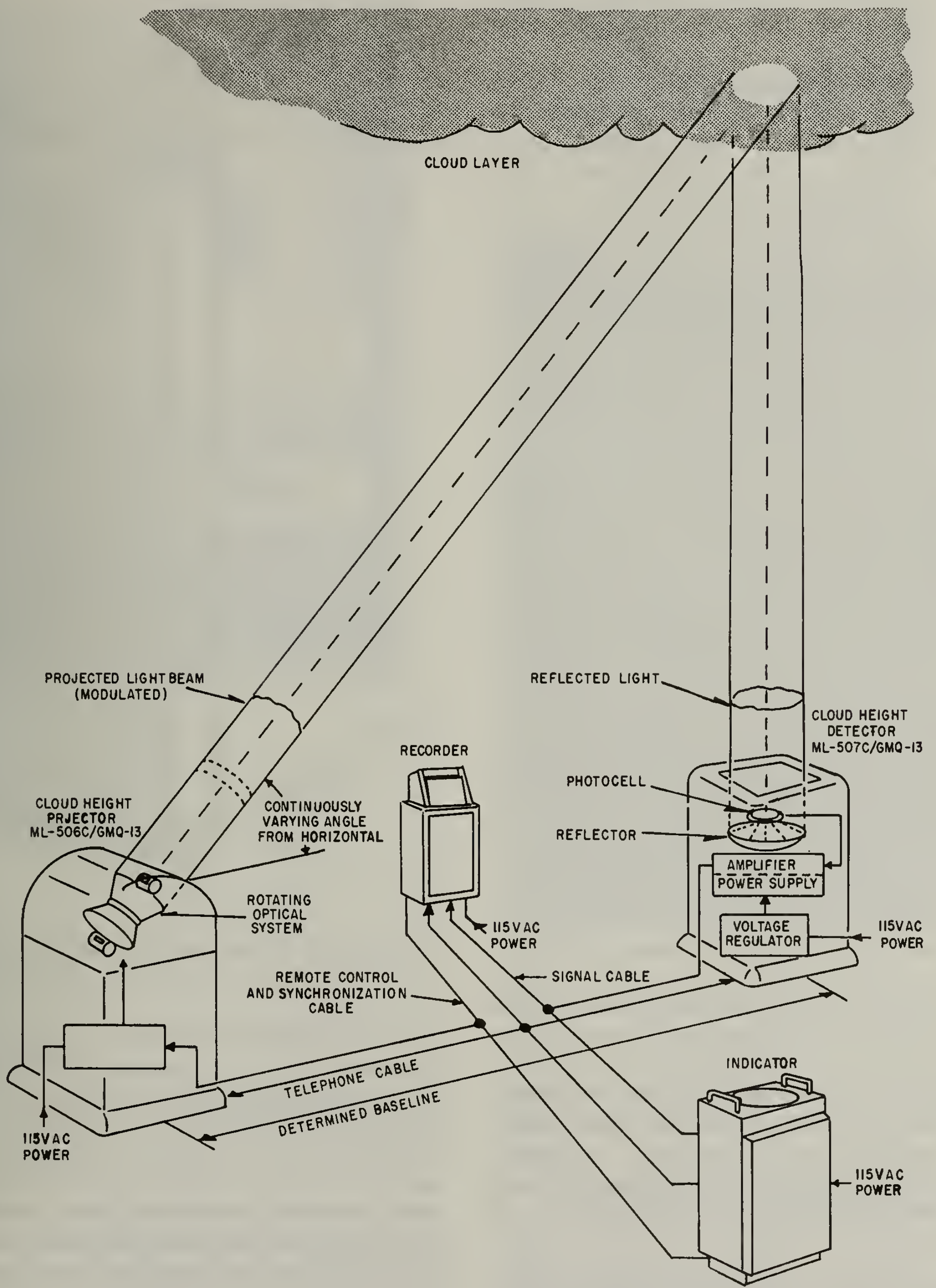
The cloud height set system was designed to give frequent measurements from a remote location. It is used primarily at the end of an instrument runway.

Operational efficiency of the equipment is influenced by several factors. These factors may be possible interference by radio transmitters, vibration from various sources, strong induction fields, or proximity of high-intensity lamps having a high percent of modulation.

From an observational standpoint, it is desirable to install the equipment in the approach zone of the most commonly used instrument runway near the middle marker.

Components

Cloud Height Set AN/GMQ-13( ), or the rotating beam ceilometer, is composed of a detector, a projector, a recorder, and in some instances, an indicator. It is powered by 115-volt, 60-hertz alternating current. Figure 5-1-28 is a



209.132

Figure 5-1-28.—Typical installation of cloud height set AN/GMQ-13( ).

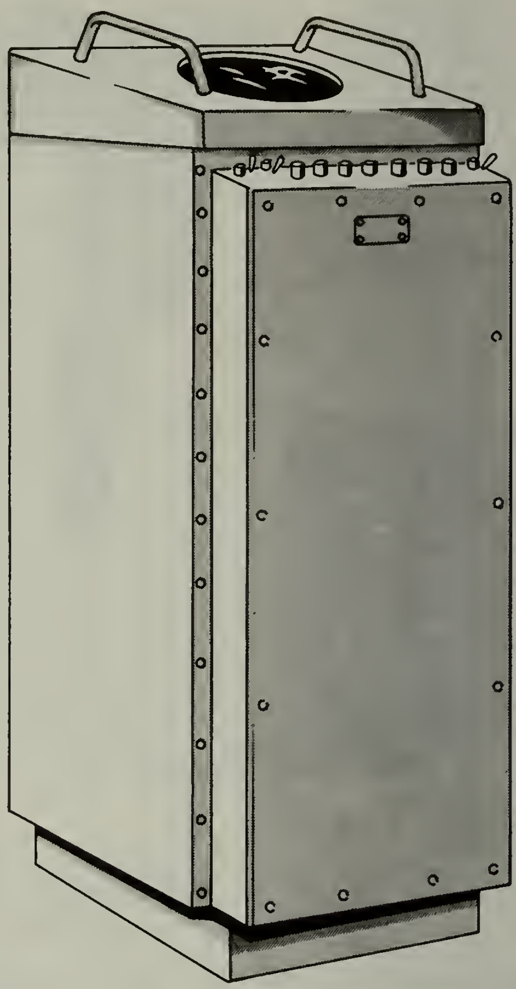
diagram of a typical installation and shows that the basic principle involved in making a cloud height measurement with a cloud height set is one of triangulation.

DETECTOR.—The detector is located at a known fixed distance (usually 400 feet) away from the projector. The field of view of the detector is directly vertically upward. As the beam of the projector sweeps the cloud base, the light reflected from the cloud base in the detector field of view is received by the detector optical system (a parabolic reflector and photoelectric cell). It is amplified by the detector amplifier. The output of the detector amplifier is fed by means of connecting cables or radio link to the recorder and/or indicator.

PROJECTOR.—The projector is comprised of two identical optical systems mounted back-to-back on a rotary mount. The modulated light beams which they project are continuously rotated in the plane of the detector's field of view. At some point in the rotation, each portion of the detector field of view from the top of the detector to the zenith is illuminated. Any cloud or other reflective obstruction causes a light spot to occur as the light beams pass. The detector photocell and amplifier produce a signal voltage corresponding to the intensity of the spot on the clouds. Two light beams are used to increase the rate of measurement and to provide a safety factor in case of failure of one optical system.

The rotary mount which carries the two back-to-back optical systems rotates at the rate of 5 rpm. This means that the rotary mount makes a complete revolution in 12 seconds and that the optical system projects a beam every 6 seconds. However, since each optical system is blocked off for one-half of the revolution through the upper semicircle, the actual sweep of each optical system is 3 seconds in duration. Therefore, each measuring sweep lasts 3 seconds and a measuring sweep is provided every 6 seconds.

INDICATOR.—The indicator (figures 5-1-29 and 5-1-30) consists of a long persistence cathode-ray tube (CRT) with the appropriate electronic and mechanical circuits. It is housed in the weather office. The electron beam of the CRT moves up the vertical axis of the tube in synchronism with the rotation of the projector. When an amplified cloud signal from the detector is fed to the indicator (cathode-ray tube), it causes the electron beam to widen momentarily as the beam moves up the face of the CRT. The point at which the electron beam widens corresponds to the angle of the projector at which the light beam strikes the cloud over the detector. The face of the CRT indicator is calibrated in degrees corresponding to the angle of projector rotation. This angular measurement can readily be converted into height by reference to precomputed tables.



209.382

Figure 5-1-29.—Cloud height indicator IP-327B/GMQ-13.

209.383
Figure 5-1-30.—Cloud height indicator IP-327B/GMQ-13 showing controls and CRT with cover in place.

RECORDER (RO-121/GMQ-13).—The recorder (RO-121/GMQ-13) which has been developed for use with this equipment is of the facsimile type. (See figure 5-1-31).

The horizontal motion of the stylus is synchronized with the rotation of the projector. The density of the record varies directly with the signal strength.

Recording Charts AN/GMQ-13( ).—The cloud height recording charts should be handled as follows:

- Enter the station name, time check, and date-time (LST) group at the beginning and the end of the chart or any detached portion of the chart.

- Enter the time check and date-time group near the trace during periods of operation at the time of each 6-hourly observation, when notified of an aircraft accident at or in the vicinity of the station, and when the recorder is stopped or started.

209.384
Figure 5-1-31.—Cloud height recorder RO-121/GMQ-13.

- When the chart is adjusted for time enter the date and time (date/time GMT) with an arrow pointing to the spot of adjustment. Make time adjustment when the error at time of inspection exceeds 2.5 minutes.

- Retain complete ceilometer records for 3 months, after which they may be destroyed unless otherwise instructed.

BALLOON DETERMINATIONS

The standard balloon specifically designed to measure the height of clouds (ceiling) is the 10-gram black or dark blue ceiling balloon. The ceiling balloon is normally used to determine the height of the ceiling when the broken or overcast layer of clouds is 2,500 feet or less. Sometimes it is desirable to obtain a more rapid ascent than can be obtained with a 10-gram balloon—for instance, when taking a balloon ceiling under adverse wind conditions. Under adverse conditions or when it is necessary to save time, it is permissible to use either a 30-gram balloon or a 100-gram balloon, depending on the desired ascension rate. When using either of these two balloons, choose the appropriate color of balloon; use red balloons for thin clouds and black balloons under other conditions.

The Universal Balloon Balance (ML-575/UM) is used to inflate the 10-gram ceiling balloon. The nozzle lift should be so adjusted that it weighs EXACTLY 43 grams when inflating the balloon with helium.

Since the ceiling balloon is not used to reach altitudes much beyond 2,500 feet, the rapidity of inflation is not highly important; however, an attempt should be made to inflate it in about .75 minute to 1 minute.

Ceiling balloons should be stored in a dry, warm environment. The temperature should be as high as possible but should not exceed 120 °F. When the balloons have been exposed to temperatures below freezing, they should be stored at a temperature of 65 °F or higher for at least 12 hours prior to removal from their container. They should not be placed immediately adjacent to the large electric generators or motors. Motors and generators emit ozone which is detrimental to neoprene. Balloons lose their strength with age; they should be used in the order of their production dates to avoid excessive aging. Ceiling balloons need not be conditioned prior to use.

When using a ceiling balloon, note the length of time (use a stopwatch or any watch having a second hand) that elapses between the release of the balloon and entry into the base of the layer. The point of entry is considered as midway between the time the balloon first begins to fade and the time of complete disappearance. Determine the height above the surface corresponding to the nearest 5 seconds of elapsed ascent time from tables found in FMH-1B. The accuracy of this height is affected when the balloon does not enter a representative portion of the cloud base; when it is used at night with a light; or if obtained during the occurrence of hail, ice pellets, freezing rain, or moderate to heavy rain or snow.

EQUIPMENT OUTAGE

There are many reasons why equipment outages occur—power failure, maintenance, etc. When it does occur, the following guidelines should be used:

LOGBOOK

An equipment outage logbook should be maintained listing the date, time, and reason for the outage. This book also serves as a trouble source for the maintenance personnel.

SUPERVISION NOTIFICATION

After you have entered the outage information into the logbook, promptly notify your supervisor, section leader, and/or maintenance personnel.

MF1-10 COLUMN 90 ENTRIES

When equipment outages occur you must make an entry on the MF1-10 column 90. Enter remarks on outages, changes in sensors, etc., using the following instructions as a guide:

- Enter the remarks to maintain a log of equipment outages and to explain the reason for change in type of equipment used in taking an observation—e.g., "0440 RBC/RWY 19 OUT," "1137 ML-102 INOP, BEGAN USING ML-573."

- Enter an appropriate remark when the equipment is operating properly but when the indications are considered nonrepresentative for reporting purposes. For example, enter "1057 GMQ-29 or AN/UMQ-5 NON-REP DUE TO ACFT" to indicate that a helicopter in the area

of the wind sensor equipment is causing incorrect indications on the recorder and wind data have to be estimated for the observation.

- Enter a remark for changes in the instrumentation which are not related to a change in the active runway. Most commonly, this remark is necessary to reflect a switch in equipment recorders or indicators, or use of a sensor for other than the active runway, and other Column 90 entries do not indicate the reason for the change. For example, to indicate that the transmissometer recorder is switched in order to obtain the rollout RVR during an outage of rollout RVR digital displays.

- Enter the data source when the equipment is inoperative or nonrepresentative and the data was determined by an individual other than the duty weather observer—e.g., "GMQ-10 INOP 0815-1500, RVR BY SOF 0930-1157," "GMQ-10 NON-REP, RVR BY SOF 0930-1157."

EXERCISE (5-1-4)

Write the missing words in statements 1 through 5.

1. **The transmissometer AN/GMQ-10( ) is designed to provide visibility in the range of 0.05 to 2 miles in the daytime and 0.1 to 2 miles in the nighttime when a __________ foot baseline is used.**

2. **The visibility values that are displayed on the RVR should be multiplied by a factor of __________ in order to obtain the correct readings.**

3. **The ceiling light (ML-121) should be installed so that a standard baseline near __________ but can be established so that supplementary baseline near 400 and 1,600 feet can be marked.**

4. **The standard balloon specifically designed to measure the height of clouds, ceiling, is the __________ gram balloon.**

5. **When equipment outages occur, an entry on the MF1-10 column __________ should be made.**

MAINTENANCE AND MATERIAL MANAGEMENT

The Navy's maintenance and material management system (3-M) which is composed (for meteorological purposes) of the shipboard 3-M System OPNAVINST 4790.4( ), the Naval Aviation Maintenance Program (NAMP), and the Meteorological and Oceanographic Equipment Program (MOEP) of the Naval Oceanography Command is sponsored and directed by the Chief of Naval Operations. It is applicable to all meteorological and oceanographic equipments and instruments.

The Naval Air System Command and the Naval Sea System Command are the largest contributors of the Systems Commands of meteorological and oceanographic equipments to Naval Oceanography Command units. They contribute a variety of mechanical, electrical, and electronic equipments as well as instruments with performance capabilities that reflect the latest technical developements. The Navy's maintenance and material management system includes programs for preventive maintenance. It also includes methods for collecting large amounts of information on malfunctions which can be analyzed to determine corrective action to prevent recurrences.

PLANNED MAINTENANCE SYSTEM (PMS)

Both the shipboard 3-M System and the NAMP use a planned maintenance system as a subsystem for a more efficient operation. The PMS, when properly carried out, attains and maintains maximum operational efficiency of meteorological equipment, reduces outages of the equipment, and reduces the cost of maintenance in both money and man-hours. The PMS pertains to preventive rather than corrective maintenance. The PMS reduces complex maintenance to simplified procedures and assists in controlling preventive maintenance. It also detects areas requiring additional emphasis on training and techniques.

The PMS is based upon the proper utilization of necessary management tools. These include the Maintenance Index Pages (MIPs), Maintenance Requirements Cards (MRCs), preventive maintenance schedules, and Maintenance Data System (MDS).

Responsibilities

The commanding officer has overall responsibility for ensuring that ship maintenance is performed in accordance with the 3-M System procedures.

As a weather observer you are frequently assigned preventive maintenance duties. These assignments are made by a work center supervisor or preventive maintenance petty officer. You are responsible to that person. Your duties include, but are not limited to, the following:

- Reading the weekly schedule.

- Performance of assigned scheduled maintenance requirements in accordance with the MRCs and EGLs.

- Promptly notifying the work center supervisor whenever:

  (a) Anything on an MRC is not fully understood or appears to be incorrect.

  (b) Tools, material, etc., prescribed by the MRC are not available.

  (c) Any doubts about the capability, training, or experience to properly perform the MR (Maintenance Requirement) as prescribed.

  (d) Factors exist which would make performance of the MR (Maintenance Requirement) unwise or dangerous (e.g., disassembly of equipment needed for operations, radiation when prohibited, situations causing a safety hazard to exist, etc.).

  (e) Discovery of equipment deficiencies or casualties.

- Informing the work center supervisor when you have completed planned maintenance requirements and of any problems encountered in doing them under current schedules and/or MRCs.

- Notifying the work center supervisor of the pertinent details of any corrective maintenance action so that the maintenance may be documented if necessary. Particular attention must be given to the cause code and remarks/description entries.

WORK CENTER PMS MANUAL

The Work Center PMS Manual is that portion of the Departmental Master PMS Manual that contains only the planned maintenance requirements applicable to a particular work center. It is designed to provide a ready reference of planned maintenance requirements for the work center supervisor. The manual should be retained in the working area near the Weekly PMS Schedule.

Maintenance Index Pages (MIPs)

A maintenance index page is used for each set of the MRCs and is employed by the preventive maintenance petty officer for ready reference in conjunction with the planning and scheduling of preventive maintenance. A shipboard MIP is shown in figure 5-1-32.

SYSTEM, SUBSYSTEM, OR COMPONENT	REFERENCE PUBLICATIONS	DATE
AN/UMQ-5,5B,C,D Wind Measuring Set	NAVWEPS 50-30FR-525	July 1975

CONFIGURATION THESE MAINTENANCE REQUIREMENTS ARE APPLICABLE TO EQUIPMENT IN WHICH THE FOLLOWING CHANGES HAVE BEEN ACCOMPLISHED: None

SYSCOM MRC CONTROL NO.	MAINTENANCE REQUIREMENT	PERIODICITY CODE	SKILL LEVEL	MAN HOURS	RELATED MAINTENANCE
75 DP12 N	1. Inspect transmitter, transmitter support, and cable.	S-1	AGAN	0.3	None
75 DP13 N	1. Inspect indicators.	S-2	AGAN	0.2	S-3
75 DP14 N	1. Clean, inspect, and lubricate wind data recorder.	S-3	AG3	0.5	S-2
	1. Schedule on-site calibration of wind measuring set.	S-4 **			
	1. Schedule MRCs S-1, S-2 and S-3 for accomplishment between on-site calibrations. 2. Omit MRC S-3 if wind data recorder is not installed. No feedback report required. **For scheduling purposes only. No MRC is provided.				

MAINTENANCE INDEX PAGE (MIP)
OPNAV 4700-31C) (REV. 3-68)

SYSCOM MIP CONTROL NUMBER C-713/1-75

209.79.1

Figure 5-1-32.—Maintenance index page (MIP).

Maintenance Requirements Cards (MRCs)

The maintenance requirements card is designed to define the preventive maintenance task in terms that allow you to know what is required in the job and to standardize the preventive maintenance procedures.

The MRC also states the tools and materials needed in performing the task along with the safety precautions that should be considered.

A typical shipboard MRC is illustrated in figure 5-1-33.

Each MRC contains the following information and instructions:

- *System Subsystem*, and *Component*. Used for identification of the equipment involved.

SYSTEM	COMPONENT	M.R. NUMBER	
Communications and Control	AN/SMQ-1 Radiosonde Receptor	C-116	Q-2
	MAINT. SIGNIFICANT NO.		
SUB-SYSTEM	RELATED M.R.	RATES	M/H
Radio Communications	None	ETSN	0.5

M.R. DESCRIPTION

1. Measure receiver signal to noise ratio.

TOTAL M/H: 0.5

ELAPSED TIME: 0.5

SAFETY PRECAUTIONS

1. Observe standard safety precautions.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Signal generator, AN/URM-26 or equivalent
2. Electronic multimeter, AN/USM-34 or equivalent

PROCEDURE

Preliminary

a. Turn MAIN POWER switch on power supply to OFF.
b. Loosen the four jam locks and pull receiver from cabinet to the full out stops.
c. Pull interlock, located on the front left side of cabinet, to its out position.
d. Set ANTENNA SELECTOR switch to 2.
e. Turn HI RF GAIN control fully clockwise.
f. Set signal selector switch to GND.
g. Disconnect antenna from J2002, located on the back of the front panel.
h. Connect multimeter to J2013 and ground, located on top left of receiver chassis, using 0-1V AC scale.
i. Turn MAIN POWER switch to ON.
j. Energize signal generator.
k. Remove the recorder cable from J2016.

1. Measure Receiver Signal to Noise Ratio.

a. Adjust main tuning control and ANT TRMR for maximum output on multimeter, and note meter indication.

(Cont'd on Page 2)

LOCATION

Page 1 of 2 | CK | 135A | RG4 | 25 | AS38 | Q

209.79

Figure 5-1-33.—Maintenance requirements card for AN/SMQ-1.

Procedure (Cont'd)

b. Set signal generator to 400 MC, adjusted for 30 percent 400 cycle modulation and zero output.
c. Connect output of signal generator to J2002 with CG-409/U cable.
d. Increase the signal generator output until the multimeter indication is 1.4 times the amount noted in step a. The signal generator output should not exceed 1.0 microvolt.
e. Observe main tuning dial indication for proper alignment. Main tuning dial should indicate 400 plus or minus 0.4 dial division.
f. Vary SPEAKER VOLUME control and observe increase or decrease in audio signal.
g. Adjust the FOCUS and INTENSITY control for clear presentation on the scope.
h. Stabilize presentation of scope by adjusting the LKG control.
i. Turn MAIN POWER switch on power supply to OFF.
j. Reconnect recorder cable to J2016.
k. Disconnect test equipment and return receiver to cabinet.
l. Return equipment to normal condition.

Page 2 of 2	CK	135A	RG4	25	AS38	Q

209.80

Figure 5-1-33.—Maintenance requirements card for AN/SMQ-1—Continued.

- *MRC Code.* The code, consisting of two parts is assigned to the card. The first part of the MRC code corresponds to the first portion of the number identifying the applicable MIP; the second part identifies the periodicity for the maintenance action, using a letter code for the repetitive time element as follows:

Periodicity Codes

D—Daily

W—Weekly

M—Monthly

Q—Quarterly

S—Semiannually

A—Annually

- *Maintenance Requirement Description.* A brief definition of the PMS action to be done.

- *Rates.* The recommended skill level of the person who should be qualified to do the work, identified by rate or NEC (Navy Enlisted Classification). Qualified personnel other than that specified may be assigned.

- *W/H (Worker-Hours).* The average time for each piece of equipment required to do the maintenance required. Total W/H and elapsed time to the nearest tenth of an hour for each piece of equipment are also listed. It does not include time for tool preparation and return, that is needed for removal and/or replacement of interference, or that is required for operational tests except when included on an MRC.

- *Safety Precautions.* A listing of those precautions which direct attention to possible hazards to personnel or equipment while doing maintenance.

- *Tools, Parts, Materials, Test Equipment.* Those tools, parts, and materials necessary for the maintenance action.

- *Procedure.* The sequence of detailed steps to be followed in doing the maintenance action. The card may contain blanks in which ship's company must supply certain data necessary to do the work properly; e.g., pressure settings, temperature settings, brush tension, limiting speed, tolerances, and levels.

- *Location.* The location of the equipment; or is used for alerting maintenance personnel to the existence of EGLs.

- *Date.* The month and year when the MRC was prepared.

- *SYSCOM MRC Control Number.* Numbers located vertically along the lower right side of the MRC. It is a library identification number which is unique to each MRC.

Preventive Maintenance Schedules

In order to ascertain that proper preventive maintenance is being performed on all meteorological equipment, the preventive maintenance petty officer normally prepares a variety of schedules—annual, quarterly, and weekly. Figure 5-1-34 illustrates a sample weekly preventive maintenance schedule.

The preventive maintenance petty officer, after making sure that the maintenance task has been completed, notes the completion on the appropriate schedule. In this manner, a visual display of preventive maintenance scheduled, completed, or requiring rescheduling is presented. Shown on the weekly PMS Schedule are the following headings:

- Work center code
- Date of current week
- Division officer's signature
- MIP Code minus the Date Code
- A list of applicable components
- Maintenance responsibilities assigned, by name, to each line item of equipment
- The periodicity codes of maintenance requirements to be performed listed by columns for a specific day

WEEKLY PMS SCHEDULE (CONVENTIONAL)
OPNAV FORM 4790/15 (3-71)
S/N 0107-LF-770-3280

*U.S. GPO: 1973-710-239

WORK CENTER: EA04
PMS SCHEDULE FOR WEEK OF: 7-14 OCTOBER
APPROVAL SIGNATURE: J F Hawley

MIP	COMPONENT	MAINTENANCE RESPONSIBILITY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT.-SUN.	OUTSTANDING REPAIRS AND P.M. CHECKS DUE IN NEXT 4 WEEKS
A-001/301	STEERING GEAR	KICKLIGHTER	D-3R W-1R	D-3R	D-3R	D-3R	D-3R	D-3R D-3R	D-3R W-1R W-2R W-3R M-1R
		KICKLIGHTER	W-8 W-2R W-3R						Q-4R A-2R A-3R A-9R R-1 R-90 R-10
A-003/025	HP AIR COMPRESSOR	LONG	W-3						Q-9R A-11R A-13R 36M-2R
		LONG							R-1 R-2W R-3 R-4 R-5 R-7 R-8 R-9 R-10 R-11
		LONG							R-12 R-13 R-14 R-15 R-16 R-18 R-19
A-005/361	ANCHOR WINDLASS	WARREN	W-1 W-2 W-8		M-9				M-2R R-1 R-2 R-3 R-8
A-009/090	TUMBLER DRYER #1	ABOY		M-1	M-2 M-3				
A-009/090	TUMBLER DRYER #2	ABOY							S-1 M-1 M-2 M-3

UPDATE THIS SCHEDULE DAILY

209.80.1

Figure 5-1-34.—Weekly PMS Schedule.

- Outstanding major repairs, applicable PMS requirements and all situation requirements

NOTE: A detailed description of the shipboard 3-M System may be found in the *Ships' Maintenance and Material Management* (3-M) *Manual*, OPNAVINST 4790.4.

NAVAL AVIATION MAINTENANCE PROGRAM (NAMP)

The NAMP format is different. Its description may be found in OPNAVINST 4790.2. However, as an aerographer you most frequently use the shipboard version since at shore stations the Meteorological and Oceanographic Equipment Program (MOEP) is usually used.

METEOROLOGICAL AND OCEANOGRAPHIC EQUIPMENT PROGRAM (MOEP)

The commanding officers of ships and stations are assigned the responsibility for the maintenance of assigned meteorological and oceanographic equipment. The services of MOEP personnel are available to assist with maintenance problems beyond the capabilities of local technical personnel and facilities. Detailed information concerning the MOEP is provided in the *U.S. Navy Meteorological and Oceanographic Support Manual*, NAVOCEANCOMINST 3140.1( ).

Purpose of the MOEP

The accurate measurement of atmospheric and oceanographic parameters is vital to optimum Navy operation in the total environment. This is possible only with properly installed, operated, and maintained equipment. This equipment is unique. It varies from relatively simple but precise instruments to highly complex electronic devices. The MOEP provides the necessary guidance and technical assistance to ensure effective and economical equipment installation, operation, and maintenance. The program is staffed with specially trained and experienced officers designated as Meteorological and Oceanographic Equipment Technical Liaison Officers (MOETLOs). Additional personnel include a select group of civilian engineers and military technicians.

Utilizing MOEP Services

All Aerographer's Mates concerned with the installation, operation, maintenance, and rework of the assigned meteorological and oceanographic equipment should use the services of MOEP personnel to assist in solving meteorological and oceanographic equipment problems beyond the capability of local maintenance personnel. Requesting procedures for MOEP assistance are described in NAVOCEANCOMINST 3140.1( ).

Ships and other naval activities requiring assistance should notify the nearest MOEP activity. Telephone requests should be confirmed by speedletter or message.

Meteorological Equipment Casualty Report (METREP)

In the event of a meteorological equipment casualty, a METREP must be sent by your command to COMNAVOCEANCOM. This METREP should provide COMNAVOCEANCOM with the information needed to decide whether or not an activity's ability to carry out its assigned mission is in any way impaired. It is also the method used to inform COMNAVOCEANCOM when the casualty has been corrected and mission assignments can be fulfilled. Detailed information concerning the METREP report is provided in NAVOCEANCOMINST 3040.1( ).

EXERCISE (5-1-5)

Write the missing words in statements 1 through 5.

1. **The PMS, when properly carried out, attains and maintains maximum __________ efficiency of meteorological equipment.**

2. **An MIP is used for ready reference in conjunction with __________ and preventive maintenance.**

3. **An MRC is designed to define the PMS task that allows you to know what is required in the job and to __________ the PMS procedures.**

4. **A detailed description of the shipboard 3-M system may be found in the Ship's Maintenance and Material Management (3-M) Manual, OPNAVINST __________.**

5. **Requesting procedures for MOEP assistance are described in NAVOCEANCOMINST __________.**

UNIT 5—LESSON 2

UPPER AIR EQUIPMENT

<u>OVERVIEW</u>

Identify the upper air equipment used in taking an upper air observation.

<u>OUTLINE</u>

Rawin set AN/GMD-1( )

Radiosonde receptor AN/SMQ-1( )

Radiosonde instruments

Balloon inflation and assembly of train

Meteorological data processor OL-192/GMD-1

UPPER AIR EQUIPMENT

There have been many advances in the technological fields of high-altitude aircraft, projectiles, missiles, and satellite development. As a result of these advances, the scientific study of the upper regions of the atmosphere is becoming increasingly more important. Since meteorologists now have access to larger quantities of data from the upper air, they are finding new and more accurate methods of forecasting the movement of storms.

The radiosonde program is one of the most important programs in the Naval Oceanography Command today. It has been said that the methods and procedures used in forecasting have, until recently, surpassed the level of material available upon which to base the predictions. This is especially true of the upper air program.

It is your responsibility to learn the correct procedures for taking upper air observations. The information derived from these observations not only assists the forecaster in making better short-range forecasts, but also aids in the scientific study of the structure and interrelationships between occurrences in the upper air and those on the surface. This lesson covers the ground equipment and flight equipment, used in taking upper air observations.

NOTE: The procedures for setting up upper air equipment for taking upper air observations can be found in FMH-3 and the appropriate technical manual.

Learning Objective: Identify the upper air equipment used in taking upper air observations.

Radiosonde observations (RAOBS) are made to determine the pressure, temperature, and humidity from the surface to the point where the sounding terminates. The radiosonde consists of

meteorological measuring elements coupled to a radio transmitter and assembled into a small lightweight box. The device is carried aloft by a balloon filled with hydrogen or helium gas. Included in the train is a small parachute to slow the descent of the instrument after the balloon bursts. This minimizes the danger of injury to life and property. As the balloon rises, measurements of pressure, temperature, and relative humidity are transmitted to a ground station. There the data are recorded automatically. You then transcribe the information into a more commonly used form and plot it on various charts or format it for computer reduction. Measurements of pressure is made in millibars, temperature in degrees Celsius, and moisture in percent of relative humidity.

As the balloon rises, it is followed either visually by an observer at a theodolite, electronically by radio-direction-finding equipment, or radar. The balloon's drift away from the release point is plotted and from this the direction and speed of the air movements are determined. The winds-aloft observation is termed a "RABAL" when the tracking is done visually and a "RAWIN" when the tracking is done electronically. A combined RAWIN and RAOB is termed a "rawinsonde." Instructions for the RABAL or RAWIN portion of the observation are contained in the FMH-5 *Winds-Aloft Observations* and is covered in unit 2 lesson 3 of this manual.

The RAOB and rawinsonde have many procedures in common. This lesson deals primarily with the equipment necessary in taking the upper air observation.

RAWIN SET AN/GMD-1( )

RAWIN set AN/GMD-1( ) is an electronic theodolite and radiosonde receiver. The directional antenna tracks a balloon-borne radiosonde to altitudes of about 100,000 feet and over horizontal distances up to about 125 miles. The angles of azimuth, the elevation of the antenna, and the height of the balloon (as determined from a radiosonde recorder) determine the position of the balloon. Changes in the computed position of the balloon over a given time are indicative of the wind speed and direction. The RAWIN set receives and amplifies the signal from the radiosonde and passes this signal to radiosonde recorder AN/TMQ-5( ). This recorder, in turn, translates the modulated signal into graphical functions of pressure, temperature, and humidity.

COMPONENTS

This section will cover three components: the tracking unit; the control recorder; and the meteorological data recorder. They are used in conjunction with each other to form the AN/GMD-1( ) system.

NOTE: For a complete description of each component refer to the appropriate operations manual.

Tracking Unit

The AN/GMD-1( ) tracking unit (figure 5-2-1) basic functions are to receive the radio frequency (RF) energy radiated by a balloon borne radiosonde and to alter this energy for the purpose of extracting desired meteorological and ranging (azimuth and elevation angles) information. The altered energy from the tracking unit is then passed on to a control recorder.

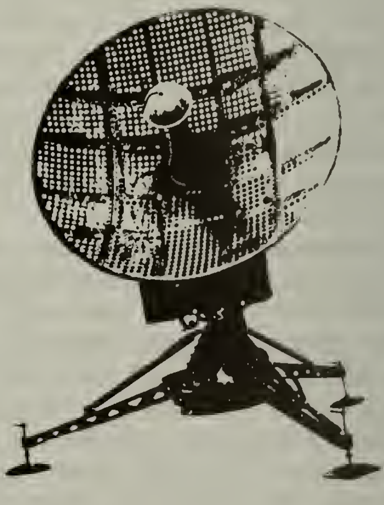


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Figure 5-2-1.—Rawinsonde System AN/GMD-1( ).

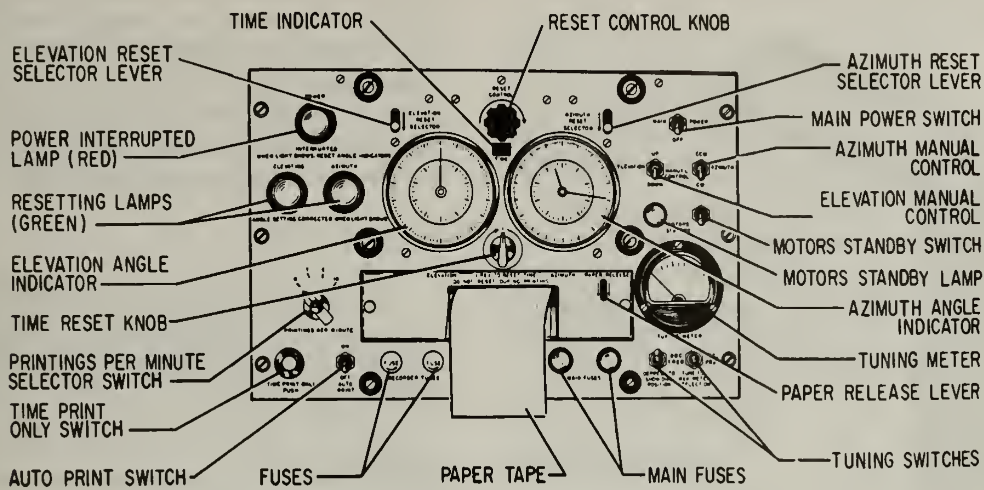

Figure 5-2-2.—Control recorder (front view).

Control Recorder

The control recorder (figure 5-2-2) acts as a remote control station for the AN/GMD-1( ) set. It also indicates the azimuth and elevation angles of the antenna (tracking unit) and produces a printed record of these angles coordinated with a time recording. This printed record of time, azimuth angles, and elevation angles are used to compute upper level winds.

Meteorological Recorder (AN/TMQ-5)

Meteorological radiosonde recorder AN/TMQ-5( ) (figure 5-2-3) records (in graphic form) weather information that is transmitted from a balloon borne radiosonde. The AN/TMQ-5 should be located as close as possible to the AN/GMD-1( ) receiver and in a quiet location to permit the monitoring loudspeaker to be heard.

NOTE: There are a number of procedures required on the AN/TMQ-5 and AN/GMD-1 before, during, and after release of the radiosonde balloon. For a complete detailed description of the procedures refer to the FMH-3 and the appropriate operations manual.

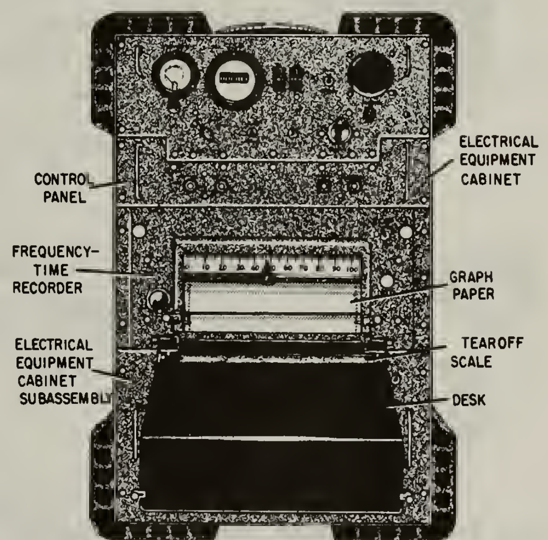

Figure 5-2-3.—Radiosonde recorder AN/TMQ-5( ).

AN/GMD-1( ) Maintenance

Maintenance of RAWIN Set AN/GMD-1( ) is limited to nonelectric maintenance. All electronic maintenance is performed by electronic personnel.

NOTE: For a complete listings of maintenance on the AN/GMD-1( ) refer to the appropriate maintenance manual.

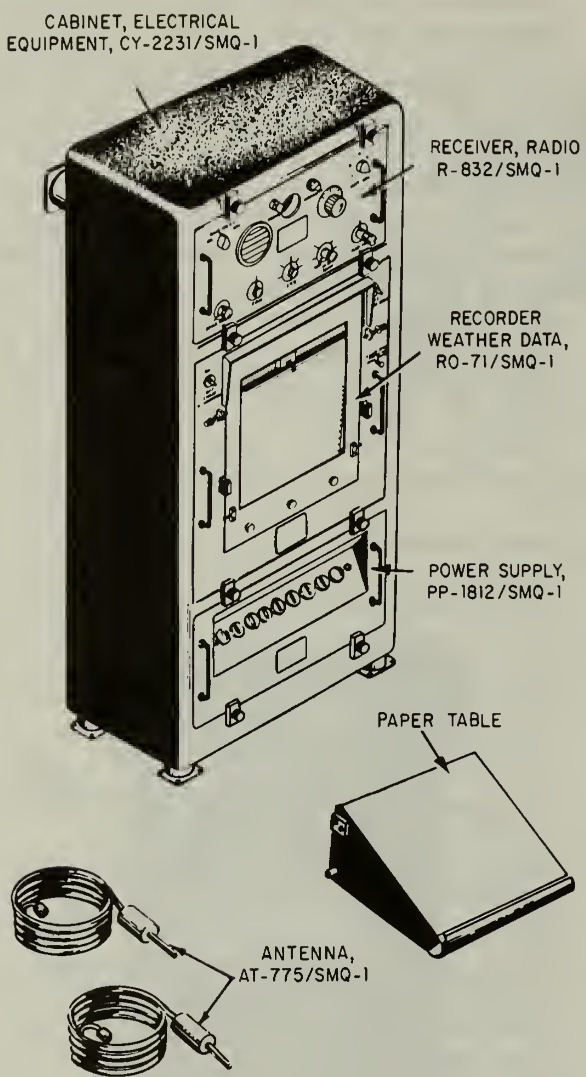

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Figure 5-2-4.—Radiosonde recorder AN/SMQ-1( ).

RADIOSONDE RECEPTOR AN/SMQ-1( )

Radiosonde Receptor AN/SMQ-1( ) (figure 5-2-4) is an electronic meteorological device which receives, amplifies, demodulates, and graphically records signals emitted from a balloon-borne 403-MHz radiosonde. The receptor covers a frequency range of 390 to 410 megahertz (MHz). The radiosonde transmits data in the form of pulsed RF (radio frequency) signals which are modulated at an audio rate controlled by the temperature, pressure, and relative humidity of the atmosphere through which the radiosonde passes. Radiosonde receptor AN/SMQ-1( ) is designed for shipboard use. However, with proper equipment modifications, the AN/SMQ-1( ) may be used as backup gear for the AN/TMQ-5( ) at shore stations.

COMPONENTS

This section will cover three components: the antenna; the receiver; and the recorder. They are used in conjunction with each other to track the radiosonde balloon.

Antenna

The antenna used with the AN/SMQ is a vertical half-wave dipole which operates over a frequency range of 390 to 410 MHz. It intercepts the signals from the radiosonde transmitter and transfers them to the receiver. The antenna consists of two insulated quarter-wave sections mounted in line and separated by an insulator. The upper section is a metal rod and the lower section is a metal tube or skirt. The antenna has a doughnut-shaped directional pattern with a null region directly above and below.

Receiver

The function of the receiver section of radiosonde receptor AN/SMQ-1( ) is to intercept the transmitted signals from the radiosonde transmitter, 403 MHz and relay these signals to the recorder where they are printed for evaluation.

The receiver consists of seven sections, each of which is an integral part of the receiver. A discussion of these sections are in the language of an electronics technician; since it is not the purpose of this course to train aerographer's mates to be electronics technicians.

Recorder

The recorder is an electromechanical device which measures the varying d.c. output voltages of the receiver; it records this information on chart paper. The recorded data is a continuously changing record of the pulsed signal repetition rate as received from a balloon-borne radiosonde.

AN/SMQ Maintenance

The AN/SMQ( ) receptor is maintained under the *Maintenance and Material Management System* (3-M). Information pertaining to the 3-M system may be found in the Standard *Navy Maintenance and Material Management System* manual.

RADIOSONDE INSTRUMENTS

The radiosonde is a balloon-borne, battery-powered instrument used together with the ground-receiving equipment to delineate the vertical profile of the atmosphere (figure 5-2-5).

Pressure is measured by means of a baroswitch which employs an expanding aneroid pressure cell to move a contact arm across a commutator bar as the pressure decreases. Temperature is measured by a thermistor; the electrical resistance of the thermistor is a function of temperature. Relative humidity is measured by a hygristor; the electrical resistance of the hygristor is a function of relative humidity and (to some extent) temperature.

Winds aloft is done by the tracking of the radiosonde by the ground equipment as covered in unit 3 lesson 9 of this manual.

Two basic types of radiosondes are the 1680- and 403-MHz. Ashore, upper-air stations use the 1680-MHz; ships use the 403-MHz.

Each radiosonde instrument must have three tests performed prior to being placed into operation. The three tests are visual inspection, electrical, and a preflight check.

NOTE: Procedures for performing these test can be found in FMH-3.

COMPONENTS

The radiosonde instrument consists of a radiosonde modulator and a radiosonde transmitter powered by a water-activated battery.

The radiosonde modulation unit (figure 5-2-6) consists of a white, plastic container housing a

Figure 5-2-5.—Radiosonde 1680-MHz.

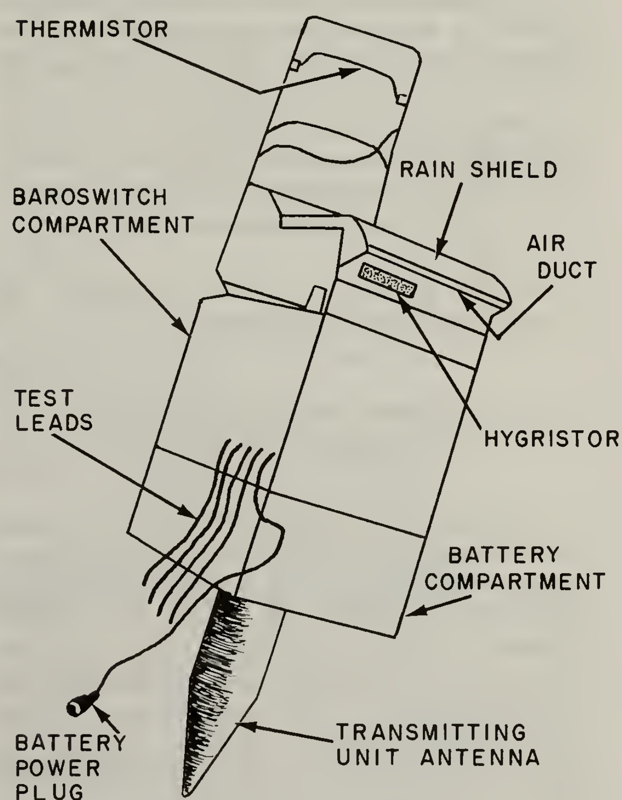

Figure 5-2-6.—Radiosonde illustration.

sensor mechanism called a baroswitch. The baroswitch has two functions in the radiosonde. First it is used to indicate pressure values during the sounding; second it is used to switch into the transmitting circuit a definite order of temperature, humidity, low reference, and a midscale reference.

The radiosonde antenna is attached to the bottom of the radiosonde. This antenna transmits the data down to the receiving equipment.

A battery power plug (extending from one side of the radiosonde) is used to connect the battery to the radiosonde. The battery pack is then placed into the battery compartment located under the radiosonde baroswitch compartment.

The thermistor (a white ceramic resistor) is mounted externally on an outrigger which exposes it at some distance from the radiosonde case.

The hygristor (a carbon-coated plastic strip resistor) is enclosed within an air duct to shield the element from direct exposure to precipitation and solar radiation.

Test leads are extended from one side of the radiosonde for use during the electrical and preflight checks. The four colored test leads are:

WHITE—ground
BLUE—low reference
YELLOW—humidity
RED—midscale reference

NOTE: If grey or green test leads are present, clip them immediately.

BALLOON INFLATION AND ASSEMBLY OF TRAIN

Rawinsonde balloons are spherically shaped films of natural or synthetic rubber (neoprene) which, when inflated with a lighter-than-air gas (hydrogen or helium), are used to transport radiosonde flight equipment into the upper atmosphere. The film thickness of these balloons is extremely thin. It is from 2/000 to 4/000 (.002 to .004) of an inch thick when inflated for release. It decreases to a thickness of one 10/000 (.0001) of an inch at bursting altitude. To state it more graphically, the film of the balloon at release is thinner than an ordinary piece of writing paper; at bursting altitude, it would take 100 thicknesses of the film to equal the thickness of a punch card. Additionally, the balloon expands in size from an approximate release diameter of 6 feet to an expanded diameter of 24 to 32 feet at bursting. It is not hard to see that the smallest cut, bruise, or scratch sustained during preflight preparation is almost sure to result in the balloon bursting at a lower altitude than it normally would have attained. Careful preflight handling of these balloons is mandatory.

STORAGE AND HANDLING OF BALLOONS

Balloons should be stored in their original sealed containers in a room isolated from large electric motors or generators. Motors and generators emit ozone which is detrimental to neoprene. Ideal temperature for storage would be in the range 10° to 30°C. Temperatures below 0°C and above 43°C should be avoided during storage. Balloons deteriorate with age; they should be used in the order of their production dates to avoid excessive aging. If by necessity balloons are stored at temperatures below 10°C, they should be removed to a room having temperatures of 20°C or higher for at least 48 hours before use to avoid any damage that would result if removed from the container and unfolded when cold. The balloons are extremely delicate, especially when softened by conditioning. No part of the balloon (except the neck) should be touched with bare hands. Use soft rubber gloves, soft cotton gloves, or use as a glove, the plastic bag in which the balloon was received to handle any portion other than the neck of the balloon.

ASSEMBLY OF TRAIN

Use as long a train as the release conditions permits—up to a maximum length of 120 feet. To avoid erroneous temperature readings, trains of less than 70 feet in length must never be used. Tie the parachute to the balloon with a double strand of 20-ply string, 5 feet long. Tie the instrument to the parachute with a minimum 65-foot length of single strand (20-ply maximum) cotton string. When the release must be made in high winds, a train regulator may be used. When a train regulator is used, the train is assembled

as follows: Tie the end of the doubled 5-foot length of cord which was used to tie the neck of the balloon to the upper end of the parachute. Tie the lower end of the parachute to the upper eye or spacer bar of the train regulator. Tie the free end of the cord from the train regulator to the ring on top of the radiosonde.

BALLOON COVERS OR SHROUDS

The radiosonde balloon cover or shroud is designed to protect the radiosonde balloon while it is being moved to the point of release and to aid in releasing it under conditions of high winds. The cover or shroud consists of a hood and four flaps, each of which terminate in a hand hold.

CAUTION: DO NOT USE THE UNTREATED SHROUD WITH HYDROGEN-FILLED BALLOONS. IT IS DANGEROUS.

RECEIVING SET, RADIOSONDE AN/SMQ-3

The AN/SMQ-3 is similar in appearance, has similar controls, and performs the same function as the AN/SMQ-1( ) receptor. However, there are some significant differences between these two receptors and the operator should be aware of them. These differences are as follows:

1. The AN/SMQ-3 has a selector switch that provides for a chart speed of 1, 2, or 4 inches per minute.
2. The signal selector switch has an RS-1 and an RS-2 position. The RS-1 position is used for normal AN/SMQ-, type sounding. The RS-2 position is used at land stations when the receptor is connected to a GMD control recorder and is being used at land stations when the receptor is connected to a GMD control recorder; it is also being used in place of a TMQ-5 recorder.
3. The signal selector must be in the RS-1 or -2 position before an image appears in the oscilloscope. In other words, the signal cannot be tuned in while the selector is in the GMD position.

METEOROLOGICAL DATA PROCESSOR OL-192//GMD-1

The meteorological data processing system is designed to gather, process, and encode the data received from the balloon borne radiosonde. The system consists of a calculator, desktop programmable computer, that is interfaced with a reader/perforator. The reader/perforator is used to punch on teletype paper tape, meteorological messages for transmission.

EXERCISE (5-2-1)

Fill in the missing words in statements 1 through 7.

1. The RAWIN set____________receives and amplifies the signal from the radiosonde and passes this signal to a recorder.

2. The____________recorder translates a modulated signal from the receiver into graphical functions of pressure, temperature, and humidity.

3. The radiosonde receptor____________is designed for shipboard use.

4. The radiosonde instrument used together with a ground-receiving equipment to delineate the vertical profile of the atmosphere is powered by a____________.

5. A____________is used to transport radiosonde flight equipment into the upper atmosphere.

6. The minimum length of a radiosonde train is____________feet while the maximum is 120 feet.

7. During conditions of____________winds, a balloon shroud may be used.

UNIT 5—LESSON 3

RADAR EQUIPMENT

<u>OVERVIEW</u>

Recognize the principles of operation, preventive maintenance, and adjustments for radar equipment.

<u>OUTLINE</u>

Radar indicators

Radar set AN/FPS-106

Radar facsimile recorder AN/GMH-6( )

RADAR EQUIPMENT

Radar and weather are very closely allied. The use of radar has provided meteorologists with a tool which permits the collection of atmospheric data under conditions when more orthodox methods fail. On the other hand, a knowledge of atmospheric conditions provides the radar operator with information vital to the accuracy of the results.

Learning Objective: Recognize the principles of operations, preventive maintenance, and adjustments of radar equipment.

Meteorological radar provides unique means of obtaining meteorological data for use by the forecaster. As weather requirements continue to expand and change, new designs and modifications to meteorological radar will continue to appear in the effort to improve and keep pace.

Due to the various number of radar sets in use throughout the Naval Oceanography Commands, this lesson will cover a description of the component parts common to some of the radars. Also basic information on the radar set AN/FPS-106 is given.

The word radar is an acronym for "radio detection and ranging." Fundamentally, all radar depends upon the emission of a short, sharp pulse of electromagnetic energy in a given direction. This pulse on intercepting a target is scattered in all directions. That part of the energy which is scattered in the direction of the radar is picked up by the radar antenna, producing an echo or "blip" on the receiver scope. The time taken for the pulse to cover the path to the target and return is a measure of the range to the target. The azimuth of the target is determined from the direction in which the pulse is emitted and returned.

RADAR DISPLAY

The purpose of the display (cathode ray tubes) in a radar is to display information to the Aerographer's Mates about the range, bearing, and elevation of surrounding targets. In general, information is presented piecemeal, and a single viewing of an display gives only a small part of the picture. Different types of radar scans are employed to display wanted information from returning echoes on the different indicators.

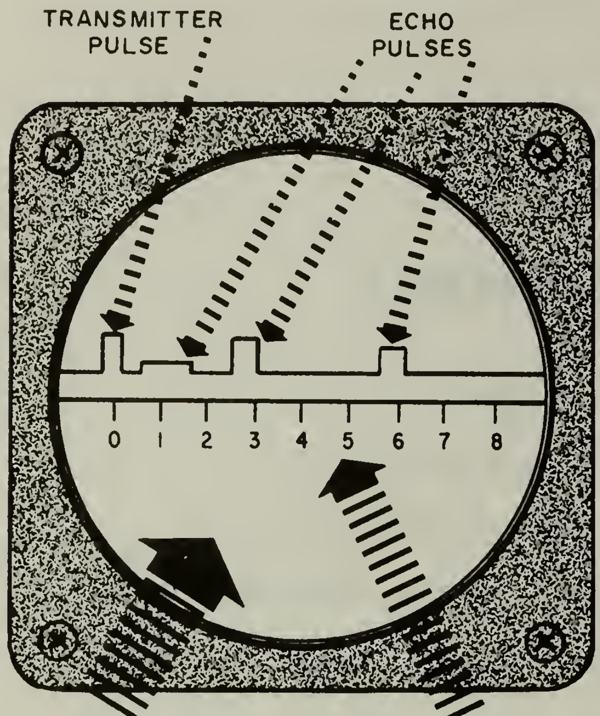

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Figure 5-3-1.—A-scan presentation.

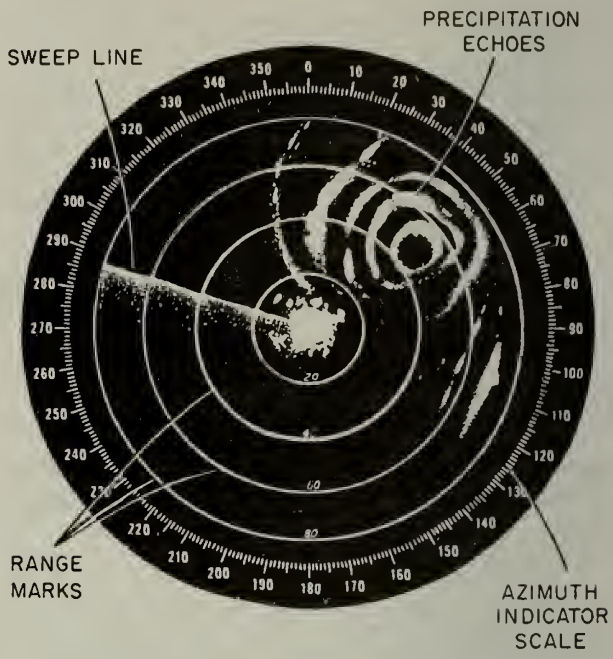

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Figure 5-3-2.—Diagram of PPI-scope.

A-Scan Presentation

The simplest type of display is the A-scan presentation, shown in figure 5-3-1. The display is one which gives the return signal intensity against the range. This display shows only the range to a target.

The bearing of the target can be found by moving the antenna horizontally to the position of maximum signal intensity (highest pip). Changing the angle of elevation of the antenna to get maximum signal intensity provides information concerning the elevation of the target.

R-Scan Presentation

The R-type scan is almost identical to the A-type. The difference between the two is that the A-scan presentation displays the total range starting at 0 range and ending at any one of several ranges selected; the R-scan presentation isolates a portion of the range scale and expands it.

PPI-Scope

Another type of display commonly used in radar is termed the Plan Position Indicator (PPI). This display makes it possible to read range and bearing information simultaneously, as shown in figure 3-5-2.

In essence, with the PPI-scope, the sweep starts at the center of the tube instead of at one edge as it does on the A-scope. As the antenna rotates around a 360° circle, the sweep rotates simultaneously. The intensity of the sweep display is modified by the presence of a return signal. Thus, the position of a target is indicated at the correct azimuth and range by a bright spot on the display tube. A picture that looks like a map is thereby produced on the tube as the antenna rotates in the azimuth plane.

Range-Height Indicator (RHI)

The PPI, previously discussed, shows the echoes as they would appear from a position high above the Earth, but gives us no indication of the vertical depth (height) of the echoes. This information is obtained through use of an RHI scope. To measure the height of an echo with radar, the horizontal rotation of the antenna is stopped and the antenna rotated up and down so that the beam sweeps vertically through the atmosphere. Echoes are recorded on the RHI, just as with the PPI. The sweep of the RHI becomes bright at ranges on the scope corresponding to ranges of echoes from the radar site.

The RHI displays a cross-section view of rain echoes (figure 5-3-3), as if we had cut a thin slice through the rain column along the line of the radar beam and then viewed the slice from the side. In viewing the RHI, the left edge of the echo is always the edge of the rain nearest the radar regardless of the direction the antenna is pointing. A three-dimensional picture of a rain column can be obtained by making numerous vertical sweeps, each at a slightly different azimuth angle, and numerous azimuthal sweeps, each at a slightly different vertical angle. However, such a process is time-consuming and is seldom undertaken in normal operations. Usually, vertical sweeps are made through the most intense or most rapidly growing parts of an echo, so as to obtain the maximum height.

Range Markers

Each of the conventional scopes provides for some direct indication of the range by the display of the range markers. The range markers may be turned on or off and may be varied.

Factors Affecting Radar Performance

There are many factors, or elements, that affect efficient radar performance, not all of

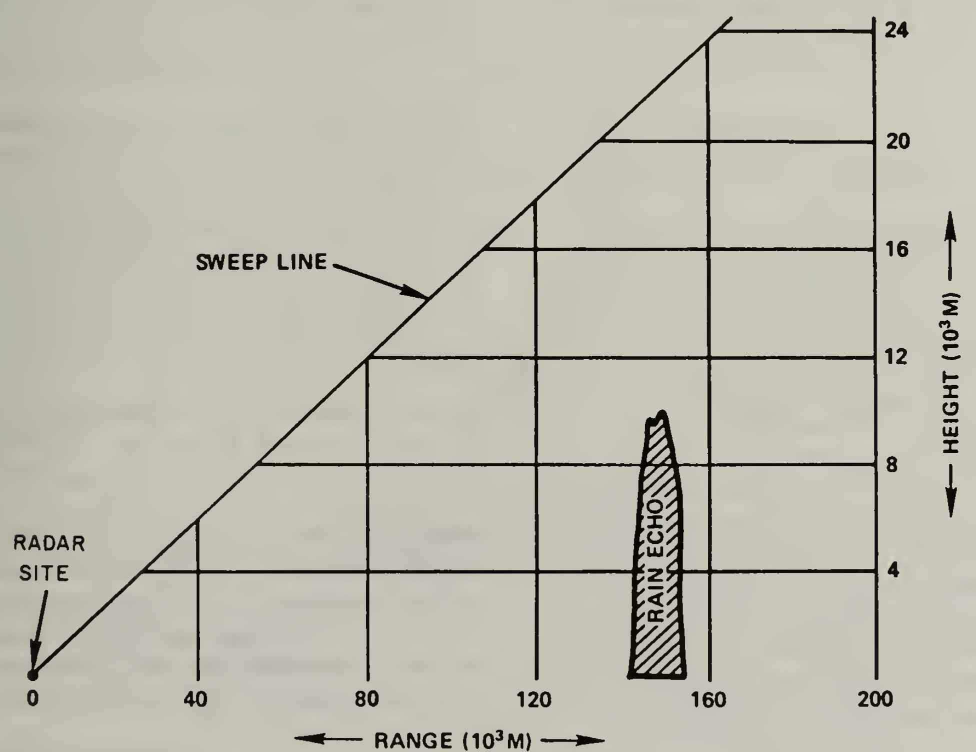

Figure 5-3-3.—Schematic of an RHI display.

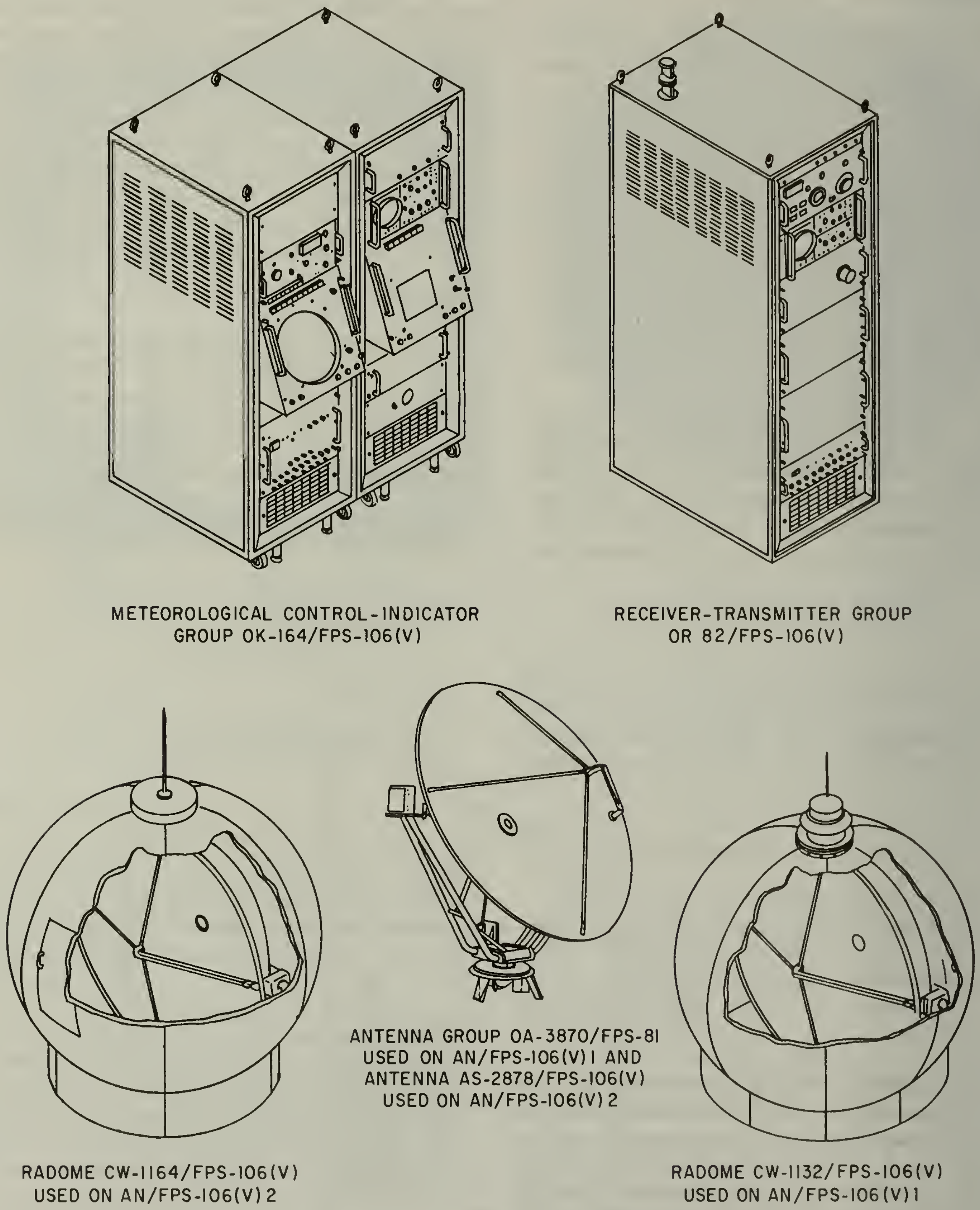

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Figure 5-3-4.—Meteorological Radar Set AN/FPS-106(V).

which are completely understood. Many of the limitations of the equipment are a result of the radar design.

RADAR SET AN/FPS-106

The meteorological radar set AN/FPS-106(V) is the newest of the Navy weather radars. It can be installed both at fixed locations and in mobile vans to detect and plot movements of storms and other meteorological phenomena. The operating range is 200 miles with an azimuth scan of 360 degrees, and elevation capability of −2 to +60 degrees.

Component Parts

The AN/FPS-106(V) consists of a receiver-transmitter group, a control indicator group, a choice of two antenna systems, depending on the type installation, fixed or mobile, and two radomes, shown in figure 5-3-4.

ANTENNA ASSEMBLIES.—Both antenna assemblies are electrically similar, but in size they differ. The fixed installation antenna is eight feet in diameter. The mobile van antenna is only six feet in diameter.

RADOMES.—The fixed-installed radome consists of rigid segments held together with bolts. A ventilator and lightning rod are mounted on top of the radome providing ventilation and lightning protection. The mobile radome differs from the fixed radome in that it consists of fewer rigid segments and a segment cover. A lightning rod is provided, but it is not ventilated.

RECEIVER-TRANSMITTER.—The RT group generates the pulses and processes the return signal.

METEOROLOGICAL CONTROL-INDICATOR.—The meteorological control-indicator group, shown in figure 5-3-5, displays the received signals in the form of azimuth, range, and elevation information. All operating controls for the radar set are located on the front panels.

Operational Procedures

The initial energization and deenergization are too lengthy for coverage in this manual and are not generally performed by the AG but by the Electronic Technicians attached to the unit. Refer to NAVAIR 50-30FPS-106-1 manual for description of the procedures in the event that no technicians are available.

NOTE: The Azimuth and elevation controls should never be engaged simultaneously, as serious damage to the gear train may result. In addition the magnetron should be placed in the standby mode when not in actual operation, this measure will increase the operational life of the magnetron.

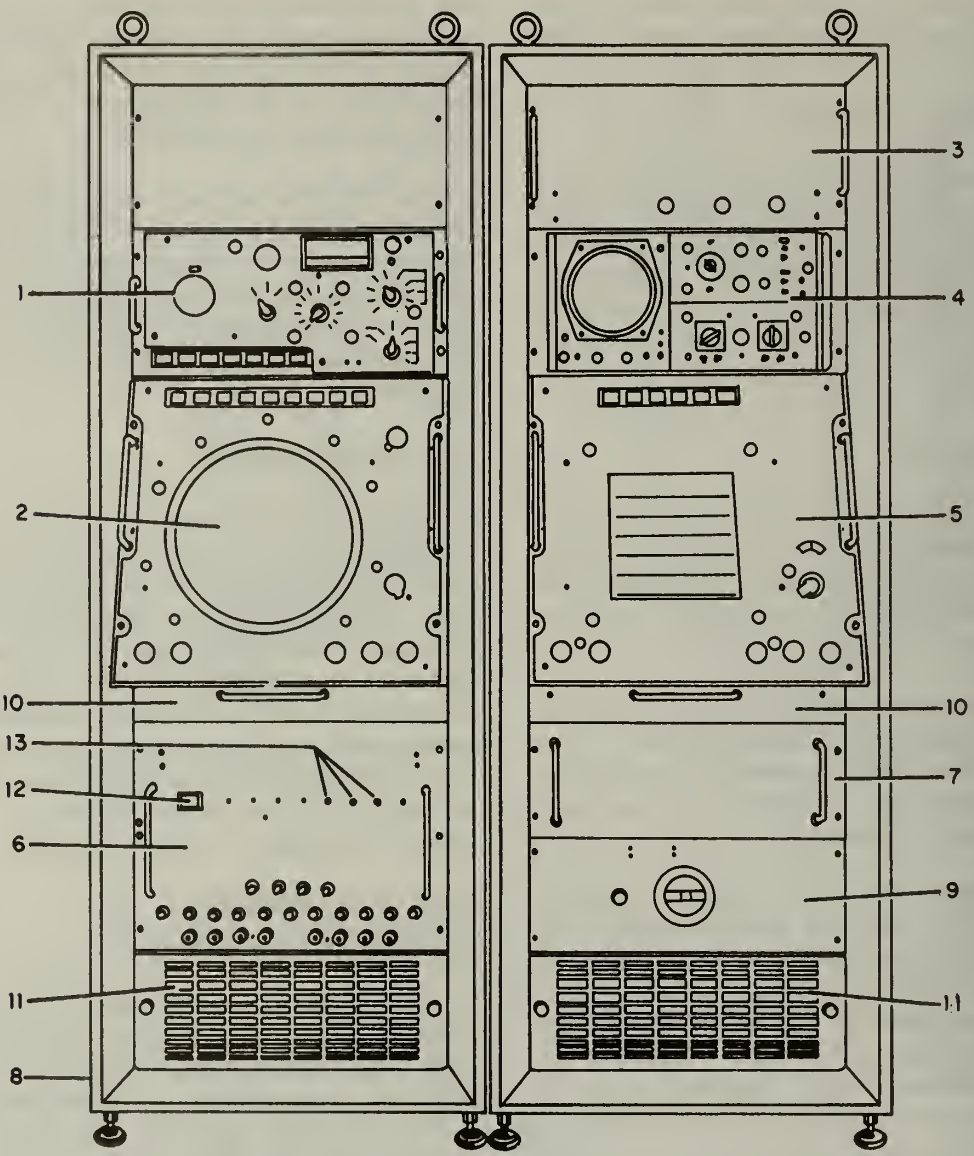
Operator Maintenance

In order to maintain a normal equipment operation with a minimum of interruption, operating personnel will check items on a daily basis. These items are outlined in the maintenance manual. The regular practice of these procedures will enable the operators to notice minor deviations from the normal operations. In the event deviations occur, operating personnel will immediately notify the maintenance personnel so that the minor deviations can be remedied before they become major problems.

RADAR FACSIMILE RECORDER AN/GMH-6( )

The Radar Facsimile Recorder AN/GMH-6( ), shown in figure 5-3-6, is used to copy the weather data transmitted from the radar/transmitter site where the transmitting device horizontally scans a Plan Position Indicator (PPI) radar scope. The data is then transmitted via telephone line to the recorder. The recorder provides a hard copy printout of the weather pictures. including "data insert information" on a continuous roll of electrolytic paper. The data insert information consists of automatic printing of a time-date code, indicating the day of the year and the time of the day that the particular picture was received and printed.

The recorder has controls that determine the frequency at which the consecutive groups of the pictures are printed. A group may consist of 1, 2, or 3 pictures. The period between the groups may vary to an infinite number of minutes. A period in this case refers to the length of time



1. Radar Set Control C-8695
2. Azimuth-Range Indicator IP-1055
3. Deflection and Video Amplifier AM-6386
4. Oscilloscope OS-224
5. Height-Range Indicator IP-1056
6. Power Supply PP-6568
7. Electronic Control-Intermediate Frequency Amplifier AM 6387
8. Electrical Equipment Cabinet CY-7009
9. Meter and Power-Indicating Panel
10. Writing and Storage Desk
11. Cabinet Cooling-Air Blower
12. AC Power Push-Button Switch
13. +150 VDC, +300VDC, and -150 VDC Indicator Lamps

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Figure 5-3-5.—Meteorological Control-Indicator Group OK-164/FPS-106(V).

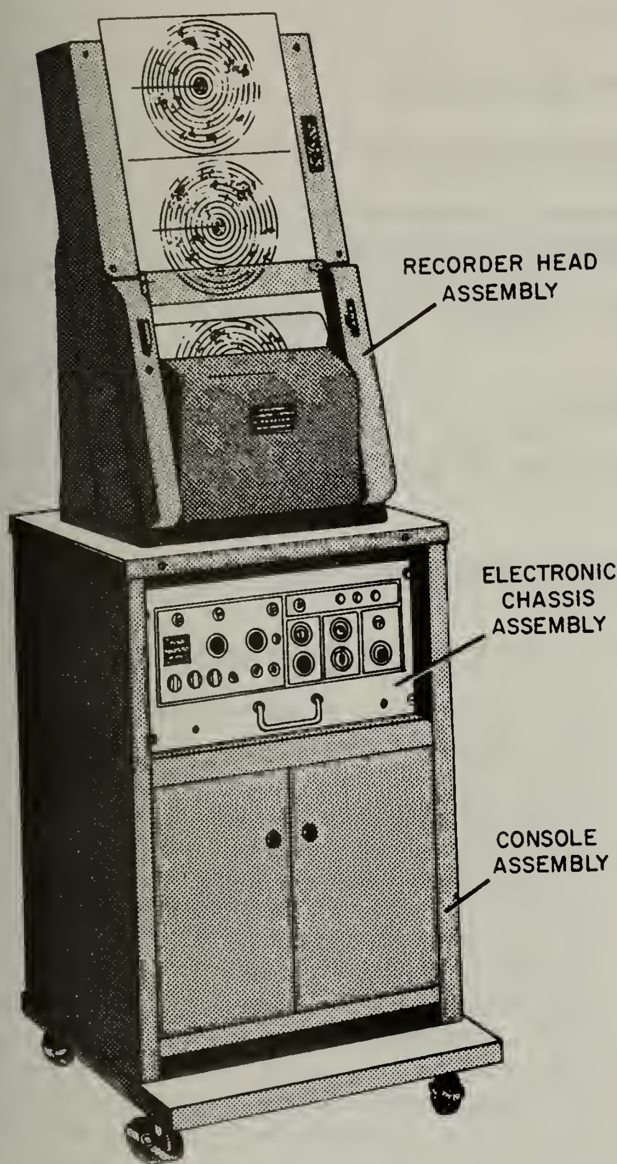

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Figure 5-3-6.—Radar Facsimile Recorder AN/GMH-6( ).

from the end of the picture of a consecutive group to the beginning of the first picture in the following consecutive group.

Controls are also provided for the adjustment of printing quality, such as the degree of contrast and whiteness. Other controls set the time and data information printed on each weather picture.

The facsimile recorder consists of the electronic chassis, and the recorder head (printing display area and paper takeup) which are mounted in and on, respectively, one metal console. The console rests on four swivel casters to permit mobility. The two front casters can be locked to fix the console in a stationary position. The electronic chassis is a slide-mounted pull-out drawer which provides for easy removal, servicing, cleaning, and testing of the chassis. The electronic chassis contains all the operating controls, fuses, and indicators for the facsimile recorder, except the paper take-up switch and fuse, the paper supply indicating light, and the paper fast feed switch, which are located on the recorder head.

Operation

Prior to operation of the Radar Facsimile Recorder, personnel should refer to the publication NAVAIR 50-30GMH6-1. Complete operating instructions are contained in this publication.

Maintenance

Servicing and maintaining this equipment are the responsibilities of trained electronics personnel. As with other complex electronic equipment the maintenance duties of the Aerographer's Mate are limited to performing standard preventative maintenance (PMS), keeping the exterior of the equipment clean, and promptly reporting any internal difficulties to the responsible parties.

Safety Precautions

High voltage is used in the operation of all radar. Extremely dangerous voltages exist in the receiver, transmitter, modulators, main console, and remote indicator. Death on contact may result if operating personnel fail to observe safety precautions. Only the authorized operation of the equipment should be carried out by the operator. All operators must know how to secure the main power, both remote and locally, to the set in use. All operators must know how to apply artificial respiration and how to contact immediate medical aid.

EXERCISE (5-3-1)

For items 1 through 6 complete the following statements.

1. **The word____________is an acronym for "radio detection and ranging."**
2. **A display on the____________scope makes it possible to read the range and bearing information simultaneously.**
3. **A PPI scope provides for some direct indication of the range by the display of the____________markers.**
4. **The operating range of the AN/FPS-106 is____________miles.**
5. **A fixed installation antenna of the AN/FPS-106 is____________feet in diameter.**
6. **The radar facsimile recorder AN/GMH-6 is used to copy a horizontally scans of a____________scope.**

UNIT 5—LESSON 4

SATELLITE EQUIPMENT

<u>OVERVIEW</u>

Recognize the basic procedures for receiving and recording of satellite imagery.

<u>OUTLINE</u>

Satellite Terminology

Satellite Observations

Ground Equipment

SATELLITE EQUIPMENT

A weather satellite is one of the most important data gathering mechanisms in the meteorological inventory. Meteorologists worldwide depend on these data sources to supplement the more "conventional" observations. These satellites currently provide cloud cover data over "area of sparse data" they fill the voids in observation that have plagued meteorologists for decades. The data is even more important since it is real time data. However, the advantages are not limited solely to cloud observations. They provide invaluable meteorological data. This includes data such as sea surface temperature, jet streams, and other significant weather data.

NOTE: Because of constant technical changes in satellite systems as well as orbiting and tracking equipment, this lesson covers only the basic information common to all ground tracking satellite equipment. For a more detailed description of satellite equipment you should refer to the appropriate operations and maintenance manual.

Learning Objective: Recognize the procedures for receiving and gridding satellite data obtained from satellite equipment.

SATELLITE TERMINOLOGY

In any field of science, there are numerous terms, definitions, and contractions that need to be understood. Without this information it is extremely difficult to understand the operational procedures and functions in the field of endeavor. The list of terms, definitions, and contractions presented in the following paragraphs is not meant to be a complete glossary. For more complete coverage you must refer to the various technical manuals pertaining to satellites. Figures 5-4-1 and 5-4-2 are diagrammatic illustrations to aid you in understanding some of the terms described below.

APT (Automatic Picture Transmission)—This is a weather satellite system that is designed to sense and transmit data in the blind.

APT TERMINAL GROUND EQUIPMENT—The receiving and recording ground station that is designed to receive and print the satellite imagery that are transmitted by a satellite equipped with APT capabilities.

APOGEE—The point in orbit at which the satellite is farthest from the center of the earth. (See D figure 5-4-1.)

ASCENDING NODE—The point at the equator at which the satellite in its orbital

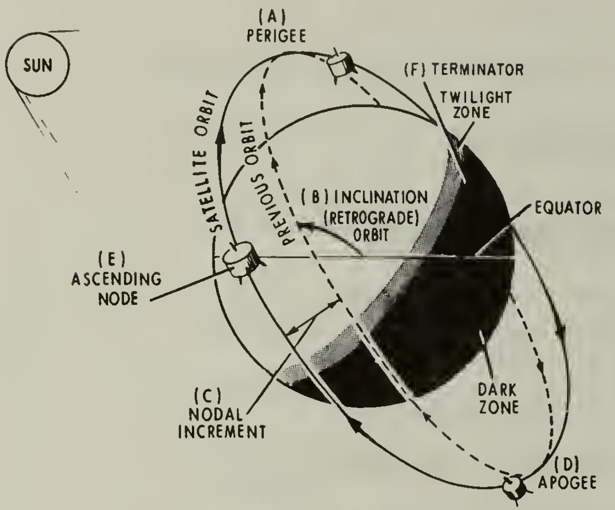

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Figure 5-4-1.—Diagrammatic drawing defining orbital satellite technology.

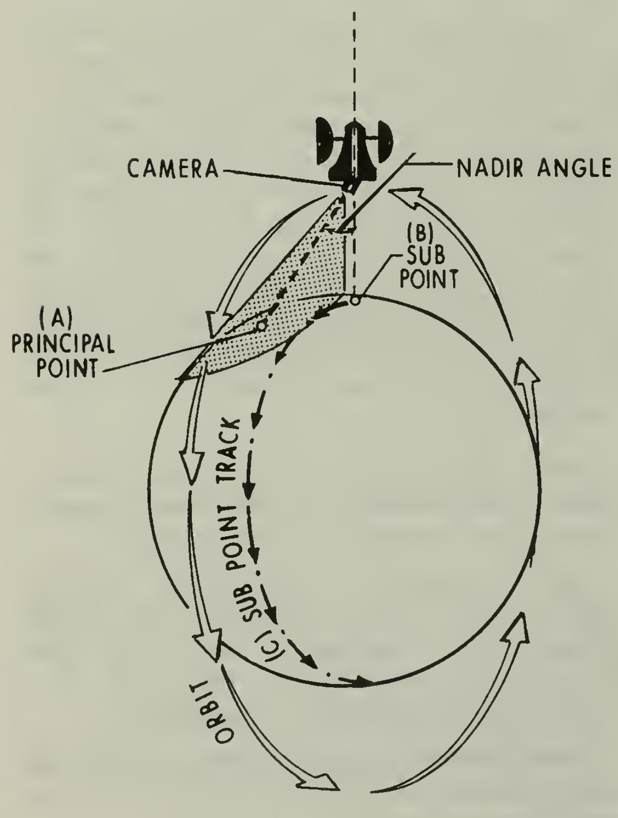

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Figure 5-4-2.—Diagrammatic drawing defining satellite tracking terminology.

motion crosses from the Southern to the Northern Hemisphere, or the point at which the satellite crosses the equator going from south to north. This is the direction in which all satellites move at the time of the ascending node. (See E figure 5-4-1.)

ASCENDING NODE TIME—The time when the satellite passes the equator going from south to north or passes the ascending node.

ATS—Applications Technology Satellite.

DEGRADATION—The lessening of picture image quality because of noise, rotation of the satellite, or any optical, electronic, or mechanical distortions in the image-forming system.

DESCENDING NODE—The southbound equator crossing of the satellite, or to put it another way, the halfway point in one orbit. (The descending node is approximately 180 degrees longitude from the ascending node.) The earth moves from under the satellite; if the earth did not move, the descending node would be exactly 180 degrees from the ascending node.

DISTORTION—An apparent warping and twisting of a picture image received from a satellite. This distortion has two causes—electronic and optical.

DMSP—Defense Meteorological Satellite Program.

EARTH-SYNCHRONOUS ORBIT—An orbit in which the motion of the satellite is synchronized with the motion of the earth so that the satellite appears stationary in time and space.

ESSA—Environmental Survey Satellite.

GMS—Geostationary Meteorological Satellite.

GOES—Geostationary Operational Environmental Satellite.

HRPT—High Resolution Picture Transmission.

METEOSAT—European Geostationary Meteorological Satellite.

INCLINATION—The angle between the plane of the satellite orbit and the earth's equatorial plane. In other words, the angle at which the satellite crosses the earth on its ascending node, measured counterclockwise from the equator. An angle of less than 90 degrees is called a prograde orbit; an angle of more than 90 degrees is called a retrograde orbit. Inclination of a retrograde orbit is expressed by 180 degrees minus the prograde inclination. Refer to B in figure 5-4-1 for an example of orbit inclination.

IR—An infrared sensor that measures radiated heat rather than reflected light.

NESDIS—National Environmental Satellite Data Information (a division of NOAA).

NOAA—National Oceanographic and Atmospheric Administration.

NODAL INCREMENT—Degrees of longitude between successive ascending nodes. (The earth moves out from under the satellite during the nodal period; the nodal increment is the amount of turning measured in degrees of longitude that takes place during one nodal period.) (See figure 5-4-1.)

NODAL PERIOD—The time elapsing between successive passages of the satellite through the ascending nodes.

ORBIT—One complete circling of the earth by a satellite from a reference point to the same reference point.

ORBIT NUMBER—Refers to a particular circuit beginning at the satellite's ascending node. The number from launch to the first ascending node is designated as ZERO.

PERIGEE—The point in orbit at which the satellite is nearest to the center of the earth. (See A in figure 5-4-1.)

POLAR ORBIT—An orbit in which the satellite passes over both of the earth's poles.

PRINCIPAL POINT—The point on earth where the camera is focused at any time during the orbit. If the camera's vertical axis is perpendicular to the earth's surface, the principal point coincides with the subpoint. (See A in figure 5-4-2.)

SMS—Synchronous Meteorological Satellite.

SR—Scanning Radiometer.

SUBPOINT—The point on earth directly below the satellite at any given time during its orbit. (See B in figure 5-4-2.)

SUBPOINT TRACK—Projection of satellite orbit on a rotating earth. It is the satellite's projected path over the earth's surface with a moving earth. From information obtained from the subpoint track, the antenna can be pointed in the direction of the satellite. (See C in figure 5-4-2.)

SUN TIME—The time of the day according to the sun. It has nothing to do with local time or Zulu time. The time that the sun is directly overhead is 1200 sun time. The time when the sun is exactly 15 degrees of longitude to the west of the longitude where it was at 1200 is 1300 sun time.

SUN-SYNCHRONOUS ORBIT—An orbit in which the satellite always passes over the equator at the same sun time on each of its orbits.

TERMINATOR—A line on the globe separating the daylight side of the globe from the nighttime side. (See F in figure 5-4-1.)

TIME PAST ASCENDING NODE—The amount of time for a body in orbit to advance from the last ascending node to an arbitrary position.

TRACKING—Procedures for keeping the antenna pointed at the satellite as it moves through its orbit.

TRACKING OR PLOTTING BOARD—Polar projection diagram of the earth centered

at either pole and extending to 30 degrees of latitude past the equator into the other hemisphere. The board has radials from the pole representing one-degree intervals of longitude; each fifth radial is accentuated. Concentric circles on the projection represent latitudes.

TRACKING DIAGRAM—The tracking diagram was constructed to show azimuth and distance of the satellite from the station for a given subpoint position.

A different tracking diagram is provided for each five-degree latitude belt. The diagram drawn for the latitude nearest to that of the ground station should be used.

TRACKING OVERLAY—This is a circular transparent disk which is centered at the pole on the tracking board. On this, you are required to plot the subpoint track of the satellite.

VHRR—Very High Resolution Radiometer.

VHR—Very High Resolution.

VISSR—Visible Infrared Spin Scan Radiometer.

VTPR—Vertical Temperature Profile Radiometer. A device which obtains data similar to the radiosonde.

WEFAX—Weather Facsimile as applied to satellite rebroadcast of ground prepared data.

SATELLITE OBSERVATIONS

At most weather stations throughout the United States, satellite information is provided routinely by the facsimile transmission of data previously received at satellite tracking centers. If, however, you are attached to an overseas station, or a ship, you are apt to be involved in obtaining your own satellite information.

This section discusses satellite applications and expansion, satellite tracking information, and instructions for gridding the obtained pictures. These procedures provide the forecaster with an invaluable means of obtaining meteorological information. The data received by this means is used to supplement the more conventional methods of observed data. In many cases, it is the only method available to observe developing storms and their associated cloud systems.

Satellite Applications

Many areas of the earth have no weather observing stations or so few that serious weather disturbances arise and move, undetected, toward inhabited regions. This allows conditions to develop to the stage where adequate forecasting occurs too late to be really effective. In many instances, even the relatively dense continental network of stations is not adequate. This is particularly true when disturbances move in from oceanic or arctic areas where weather observations are not available. The meteorological satellite provides a truly global means of observing a global phenomenon. This feature makes it an ideal meteorological observing platform providing real-time data.

A real-time data system is one which transmits data to a recipient continuously as it is acquired by the system instead of saving the data for readout at a later time. As used in this manual, the term refers to the fact that the satellite transmits meteorological data to the ground receiving equipment as soon as it senses them instead of storing them on tape for later readout.

The most commonly used satellite real-time data system is the SR scanning radiometer which acquires and transmits data during both the daylight and dark portions of the orbit.

SR SYSTEM.—The SR system for real-time transmission consists of sensors that measure radiation in the visual and infrared regions of the spectrum. The reflected light and radiated temperature values are converted to electronic signals which are then converted to cloud-type pictures by the ground receiver.

As the spacecraft moves along its orbit, the radiometer scans the earth's surface from horizon to horizon, essentially perpendicular to the orbital track. The scan across the track is generated by a mirror continuously rotating (through 360 degrees) and reflecting energy to the sensor. The data is converted to electrical signals which are then transmitted immediately to the receiving equipment.

Satellite Expansion

The meteorological satellites are continuously becoming more versatile through the addition of new and improved detection devices, as in the case of the more improved radiometers. Other improvements include picture quality through improved technology, magnetic tape storage, and more advantageous orbital positions. These continue to provide advancement in the field of satellite expansion.

There are many other meteorological uses being developed along with research in other scientific fields. These research projects are described in many available NASA and NOAA papers and are too lengthy for discussion in this manual.

Meteorological satellites have come a long way since the launch of the first experimental TIROS satellite. The United States presently has satellites in operational use that are capable of transmitting meteorological information by direct readout to ground stations. These are the ITOS/NOAA, SMS/GOES, and the DMSP. A brief description of each of these satellite systems and their capabilities follows:

ITOS/NOAA.—These sun-synchronous satellites, which are in near polar orbit, carry three subsystems for acquiring data which is stored or transmitted in real-time to readout stations. These systems are the SR, VHRR, and VTPR, all of which operate both during the day and night. However, only the SR data is capable of being received by the worldwide low-cost network of ground receiving stations. Only a few elaborate and expensive stations are capable of receiving the VHRR and VTPR data.

SMS/GOES.—The current series of geostationary satellites for meteorological data acquisition and relay are capable of both WEFAX and VISSR imagery. The receipt of WEFAX can be done by existing ground stations after a minor modification to the receiver. The VISSR data requires extensive and complex equipment.

DMSP.—Within the Navy this satellite system uses an Air Force satellite in conjunction with the Navy tracking equipment, TMQ-29 (ashore) and SMQ-10 installation (shipboard). The DMSP routinely employs two polar orbiting satellites; both have visual and IR scanning radiometers. Direct real-time readout of regional data is provided to selected military locations around the world. Data for the entire globe is provided several times per day to the Air Force Global Weather Central, Offutt AFB. This system was developed with the primary objective of providing maximum responsiveness to the military decision maker.

Satellite Tracking Data

In order for forecasters to use the facsimile picture for meteorological purposes, certain information must be furnished. Full use of the picture data depends upon acquiring a video signal transmitted by the satellite, geographically locating the picture center, orienting the picture into the correct geographical aspect, and extracting the meteorologically significant data.

In order to track the satellite and to locate, orient, and grid the facsimile picture, personnel operating the ground equipment require certain satellite predictive data; the APT daily predict message provides this required information.

The APT predict message is covered in unit 3 lesson 6 of this manual. Refer to that section for additional information.

Satellite Gridding

The satellite imagery received on the ground station's recorder are of no value to the weather forecaster unless the picture has been properly gridded. The term "gridding" refers to the process of drawing longitude and latitude lines on the received picture.

Recorders grid internally and provide a picture with latitude and longitude lines already on them. They have replaced earlier models; the exacting task of manual gridding is seldom required. Should manual gridding occasionally be required, refer to the USER'S GUIDE for detailed information.

SR Data and Application

The scanning radiometer can sense reflected and radiant energy. This gives complete coverage throughout the entire orbit, over the dark areas of the earth as well as the daylight areas.

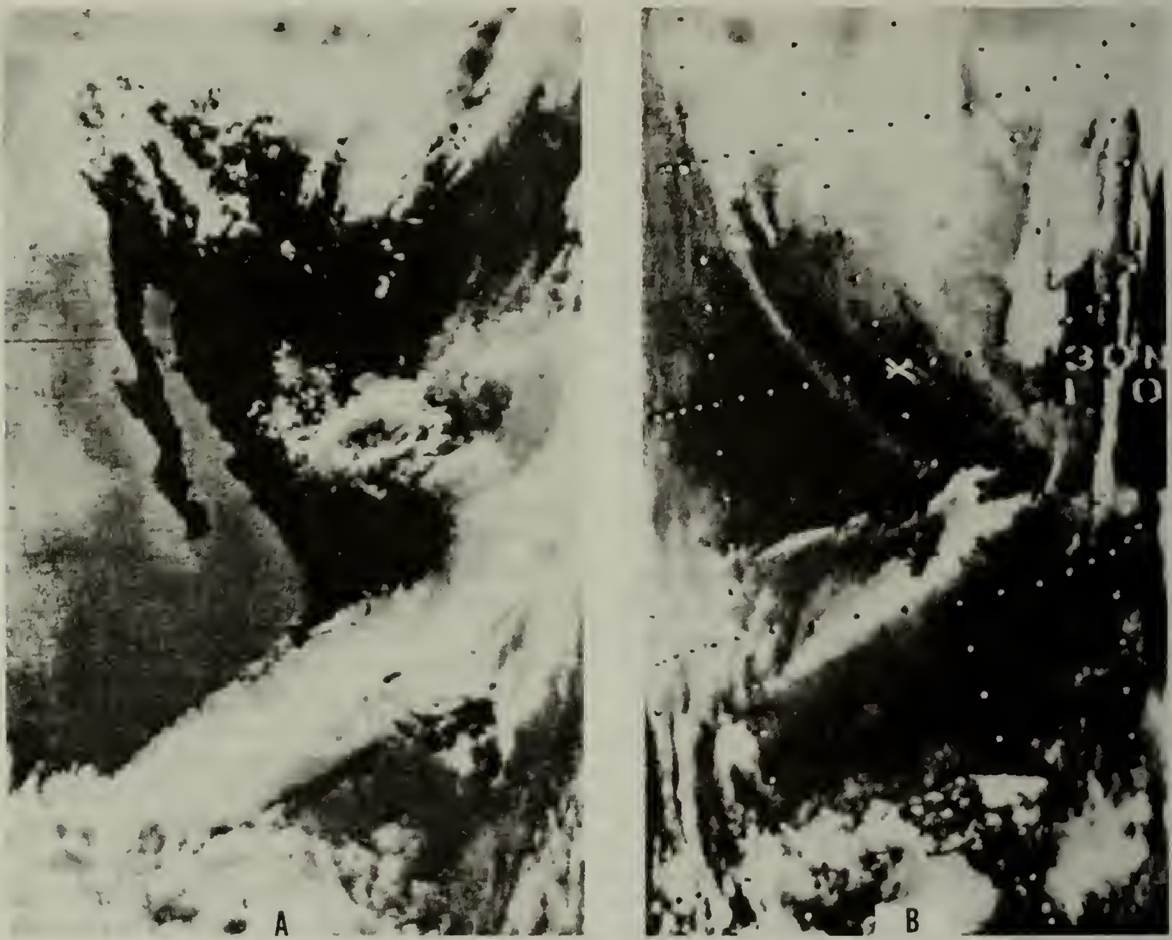

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Figure 5-4-3.—SR picture. (A) Daytime infrared view of Baja, California; (B) Nighttime infrared view of Baja, California.

The SR infrared facsimile picture looks like a distorted television picture of clouds (figure 5-4-3). Various shades of gray which appear in these pictures represent effective radiating temperatures. They are not variations of reflected visible light. The radiating temperature of a body is affected by its radiative properties as well as by its temperature. Water, ice, and various types of soil have widely varying radiative properties which affect the readings of infrared sensors. Since atmospheric temperature generally decreases with altitude, it is possible to make gross inferences about the heights of cloud tops from their temperatures shown by infrared. Some satellites can produce up to 64 shades of gray (DMSP for example). However, only three classes of temperature (shades of gray) may be readily distinguished in the pictures:

1. White areas show the coldest temperatures and therefore represent high clouds (cirrus and CB tops) or snow-covered areas.

2. Light gray areas represent moderate tropospheric temperatures and middle cloudiness. This usually means ceilings of 7,000 to 12,000 feet and little or no precipitation. The lighter shade of gray may represent a height difference of as little as 3,000 feet between the tops of middle clouds and the tops of low clouds.

3. Dark gray areas show relatively warm tropospheric temperatures. It is difficult to tell the difference between low cloudiness with little vertical development (such as small cumulus, stratocumulus, stratus, and fog) and background noise in the infrared pictures. The decision as to whether the dark gray area contains cumulus, stratocumulus, fog/stratus, or no cloud can be made easily from the VHRR pictures. On the other hand, the infrared may be used to make decisions about cloud top height that cannot be made from the VHRR pictures.

GROUND EQUIPMENT

You may encounter several types of ground tracking equipment (such as the AN/GKR-4, AN/GKR-7, AN/SMQ-6, AN/SMQ-10, and the AN/TMQ-29). However, this lesson only covers the basic data that is common to all.

Satellite Terminal Equipment

There are five basic components that make up most satellite terminal ground equipment. Not all models have all five. Also some few models may have an additional component added. They are discussed in the paragraphs that follow.

TRACKING ANTENNAS.—One component all ground equipment must have is an antenna. The antenna intercepts the signal being transmitted by the satellite. Two types of antennas are shown in figure 5-4-4. They are steerable and conical (nonsteerable). The steerable antenna can be pointed directly at the satellite. The conical (nonsteerable) antenna may be used where no local interference with an incoming satellite signal is apt to occur.

ANTENNA CONTROLS.—Receiving equipment with a steerable antenna has an antenna control and indicator component. This component contains the controls for positioning the antenna's elevation and azimuth. It also has indicators that show the direction the antenna is pointing at any given moment.

RECEIVER.—From the antenna the satellite signal is sent to a receiver. The receiver selects the proper frequency; it strengthens and varies the signal. It is similar to a FM radio receiver.

FACSIMILE RECORDER.—From the receiver the signal is then sent to a facsimile recorder that produces the picture as observed by the satellite. The recorder may be similar to the normal map facsimile; it also may be one that produces a glossy photograph with latitude and longitude lines already printed.

TAPE RECORDER.—Most terminal ground equipment has a tape recorder and amplifier. This

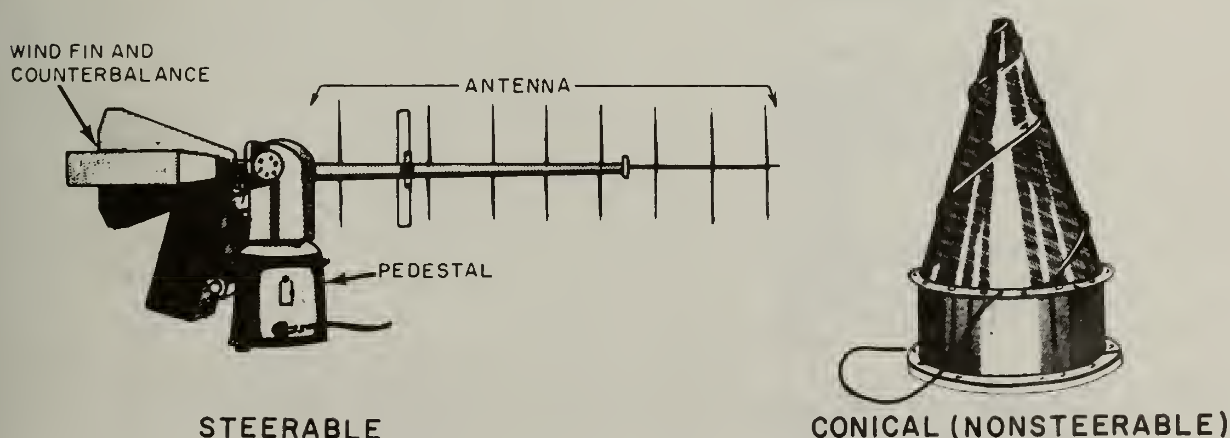

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Figure 5-4-4.—Satellite tracking antennas—steerable and conical (nonsteerable).

recorder unit is used to tape the satellite's signal so that it can be played back and a second set of pictures can be produced by the facsimile recorder. This may also be necessary if the facsimile recorder was not working properly when the satellite went over. The amplifier simply boosts the satellite signal up to a level that is usable by the recorder.

Clock

It is necessary to have a station clock readily available for the purposes of tracking the satellite and determining the times of the pictures. This clock should be accurate to a second and should have an easily read second hand.

Maintenance

Most maintenance performed on the satellite equipment is done by electronic technicians. For more detailed information on the maintenance of the satellite, refer to the appropriate operations and maintenance instructions manual.

EXERCISE (5-4-1)

Match the terms on the left with the correct definition on the right.

1.______APT

2.______Event Time

3.______DRIR

4.______Orbit Number

5.______SUN-SYNCHRONOUS ORBIT

6.______EARTH-SYNCHRONOUS ORBIT

7.______Facsimile Recorder

8.______Tape Recorder

9.______Antenna

10.______Antenna Control Unit

11.______Receiver

a. The system aboard meteorological satellites that transmit pictures immediately without storing them.

b. Produces the picture as observed by the satellites.

c. Selects the frequency, strengthens and varies the signal.

d. Intercepts the signal.

e. Controls movement of antenna and indicates its position.

f. The time a given event occurs on a satellite picture.

g. The process whereby infrared data is sensed and transmitted immediately.

h. Provides storage of satellite information.

i. Consecutive number assigned to orbits starting with the first ascending node after launch of the satellite.

j. An orbit which keeps the satellite over the same spot on the earth's surface.

k. An orbit in which the satellite always passes over the equator at the same sun time on each of its orbits.

UNIT 6

METEOROLOGICAL COMMUNICATIONS

FOREWORD

A weather observer collects a variety of valuable information ranging from oceanographic data to atmospheric conditions. This information is of little use to the forecasters if they do not have access to the observations. The forecaster's products, such as forecasts and warnings, must also be disseminated to the users of the meteorological data. To facilitate the dissemination of meteorological and oceanographic data, a variety of communications equipment and message traffic is required. Unit 6 provides the observer with the necessary information to develop skills in drafting and preparing naval messages.

(e.g., commercial contract bids) that the originator considers that no addressee need be or should be informed of any other addressee.

General messages are designed to meet recurring requirements for the dissemination of information to a wide, predetermined, standard distribution. General messages are titled (e.g., ALCOM, ALMILACT, NAVOP, etc.) and because of the title indicates the distribution, it serves as the address designator in the address line of the message heading.

Precedence

The precedence system enables message drafters to indicate a desired writer to reader delivery time. There are five precedence categories; *Routine, Priority, Immediate, Flash*, and *Emergency Command Precedence*. The assignment of precedence indicates to the drafter the desired speed of delivery to addressees, to the telecommunications center the relative order of processing and delivery, and to the addressees, the relative order in which they should note the message. Precedence, however, has no direct effect on the time that a reply must be sent or on the precedence to be assigned to that reply.

CATEGORIES.—The assignment of precedence is the drafter's responsibility, although the releaser confirms (or may change) the assignment. In order for the system to work, assignment must be based on urgency rather than importance of the subject matter.

ROUTINE

Routine (precedence prosign R) is the precedence assigned to all types of traffic which justify electrical transmission but which are not of sufficient urgency to require a higher precedence.

Examples:

1. Messages concerning normal peacetime operations, programs, and projects.
2. Messages concerning stabilized tactical operations.
3. Operational plans concerning projected operations.
4. Periodic or consolidated intelligence reports.
5. Ship movement messages, except when time factors dictate use of a higher precedence.
6. Supply and equipment requisition, except when time factors dictate use of a higher precedence.
7. Administrative, logistic, and personnel matters.

PRIORITY

Priority (precedence prosign P) is reserved for messages which furnish essential information for the conduct of operations in progress. This is the highest precedence normally authorized for administrative messages.

Examples:

1. Situation reports on position of the front where an attack is impending or where fire or air support will soon be placed.
2. Orders to aircraft formations or units to coincide with ground or naval operations.
3. Messages concerning imminent movement of naval, air, or ground forces.
4. Administrative, logistical, and personnel matters of an urgent and time sensitive nature. No higher than Priority precedence will be assigned to administrative messages except those reporting death, serious illness, or serious injury which may be assigned Immediate precedence.
5. *Weather observations with surface wind speeds 33 knots or less and all oceanographic observations.*

IMMEDIATE

Immediate (precedence prosign O) is the precedence reserved for messages relating to situations which gravely affect the national forces or populace and which require immediate delivery to addressees.

Examples:

1. Amplifying reports of initial enemy contact.
2. Report of unusual major movements for military forces of foreign powers in time of peace or strained relations.

3. Messages which report enemy counterattack or which request or cancel additional support.
4. Attack orders to commit a force in reserve without delay.
5. Messages concerning logistical support of special weapons and operational systems essential to sustain operations.
6. Reports of widespread civil disturbance.
7. Reports of warning of grave natural disaster (e.g., earthquake, flood, storm, hurricane, etc.).
8. Request for, or directions concerning distress assistance.
9. Urgent intelligence messages.
10. Requests for news of aircraft in flight, flight plans, cancellation messages to prevent unnecessary search and rescue action.
11. *Weather observations with wind speed 34 knots or greater.*

FLASH

Flash precedence (precedence prosign Z) is reserved for initial enemy contact reports or operational combat messages of extreme urgency. Message brevity is mandatory.

Examples:

1. Initial enemy contact reports.
2. Messages recalling or diverting friendly aircraft about to bomb targets unexpectedly occupied by friendly forces.
3. Warning of imminent large scale attacks.
4. Extremely urgent intelligence messages.
5. Messages containing major strategic decisions of great urgency.
6. *Tropical storms, typhoons, or hurricanes believed to be previously undetected.* Unit commanders may use Flash precedence for reporting, provided there are no extenuating circumstances that would jeopardize the tactical situation.

EMERGENCY COMMAND PRECEDENCE

In addition to the four precedences listed above, a flash preempt capability designated Emergency Command Precedence (ECP) exists within the AUTODIN system. The use of the precedence, which is identified by the precedence prosign Y, is limited to the National Command Authority and certain designated commanders of Unified and Specified commands and then only for specifically designated emergency action command and control messages.

SPEED OF SERVICE OBJECTIVES.—Because precedence is assigned according to desired writer to reader time, message drafters should be aware of factors which affect message delivery time. Some of these factors are: types of facilities, encryption/decryption requirements and types of cryptographic systems, message traffic volume, relay requirements, equipment speed, message length, number of addressees, and circuit conditions. Speed of service objectives displayed below provide general guidance. Regardless of the objectives established, it is obvious that within all telecommunications centers, message traffic is handled as rapidly as possible consistent with accuracy and security.

Precedence	Prosign	Speed of Service Objective
Routine	R	6 hours
Priority	P	3 hours
Immediate	O	30 minutes
Flash	Z	As fast as possible with an objective of less than 10 minutes

Message Components

DATE-TIME-GROUP.—The date-time-group (DTG) is assigned for identification purposes only and provides a universal time reference system. The DTG is expressed in Greenwich Mean Time (GMT), unless otherwise ordered by higher authority. It appears as a six-digit number suffixed by the letter "Z" (to indicate GMT). In addition, the abbreviated month (first three letters, e.g., JAN, FEB, MAR, etc.) and year (81, 82) are appended to the DTG.

The DTG is normally assigned by the Telecommunications Center (TCC). Commands served by a consolidated TCC may, however, elect to assign DTGs if deemed more expedient for operational or administrative purposes.

The time 2400 is not used unless it is needed to indicate a particular instant of time; instead, either 2359 or 0001 should be used. 0000 is not to be used.

A message sent by two or more transmissions is assigned the same DTG.

PLAIN LANGUAGE ADDRESS.—Plain Language Address is the phrase used to denote the format and ordinary language spelling of command short titles and geographical locations used in message addressing. The address component contains the plain language address of the originator and those of the action, info, and exempted addressees. Prior to implementation of automated message processing systems, absolute consistency in the format and spelling of plain language addresses was not critical. Deviations could be tolerated because human operators processed all traffic and their flexibility compensated for drafter inconsistencies. With the implementation of computer-aided message processing systems, format and spelling have become critical and inconsistencies cannot be permitted.

Format.—Except for collective address designators, AIGs (Address Indicator Group), mobile units and alternate command posts, the plain language address for Navy, Marine Corps, and Coast Guard activities include the activity's short title and geographic location.

The short title reflects a single activity only (i.e., dual short titles reflecting both administrative and operational titles are prohibited).

When a city or town is an integral part of an activity title, the city or town need not be repeated (e.g., NAS NORFOLK VA).

The use of punctuation is *prohibited.*

- NUMBERS AND LETTERS

All numbers from ten to nineteen are written as one word (e.g., ten, eleven, twelve. . .nineteen). All numbers above nineteen are written as two words (e.g., two zero, three four, etc.).

Examples:

1. COMDESRON TWELVE
2. COMDESRON THREE ONE

All letter designators are spelled phonetically.

Example:

1. FAIRECONRON ONE DET ALPHA

- CITIES AND TOWNS

The names of cities and towns are not abbreviated.

- STATES AND COUNTRIES

The names of states and countries are abbreviated as shown in figure 6-1-1. The names of countries which do not appear in figure 6-1-1 are spelled out.

- GEOGRAPHICAL LOCATIONS

Whenever "SAINT", "MOUNT", "POINT", or "FORT" are used as a part of a geographical location, they are abbreviated as "ST", "MT", "PT", or "FT", respectively (e.g., NAS BARBERS PT HI). Whenever they are used as a part of an activity's short title they are not abbreviated (e.g., USS POINT LOMA). "POINT" when used as a part of a task organization plain language address is abbreviated as "PT".

Examples:

1. Commander Task Group	CTG SEVEN ONE PT ONE
2. Commander Task Unit	CTU SEVEN ONE PT ONE PT ONE
3. Commander Task Element	CTE SEVEN ONE PT ONE PT ONE PT ONE

Directory.—Section 01 of NTP 3 SUPP-1 is the Plain Language Address Directory (PLAD). The PLAD is a standard listing of all Navy, Marine Corps, and Coast Guard plain language addresses. A limited number of Joint/DOD PLAs are included. U.S. Navy/Coast Guard ships are also listed.

The U.S. Army and U.S. Air Force plain language address directories are published in

States

AL	ALABAMA	KY	KENTUCKY	ND	NORTH DAKOTA
AK	ALASKA	LA	LOU1S1ANA	OH	OH1O
AZ	AR1ZONA	ME	MA1NE	OK	OKLAHOMA
AR	ARKANSAS	MD	MARYLAND	OR	OREGON
CA	CAL1FORN1A	MA	MASSACHUSETTS	PA	PENNSYLVAN1A
CO	COLORADO	M1	M1CH1GAN	R1	RHODE 1SLAND
CT	CONNECT1CUT	MN	M1NNESOTA	SC	SOUTH CAROL1NA
DE	DELAWARE	MS	M1SS1SS1PP1	SD	SOUTH DAKOTA
DC	D1ST OF COLUMB1A	MO	M1SSOUR1	TN	TENNESSEE
FL	FLOR1DA	MT	MONTANA	TX	TEXAS
GA	GEORG1A	NE	NEBRASKA	UT	UTAH
H1	HAWA11	NV	NEVADA	VT	VERMONT
1D	1DAHO	NH	NEW HAMPSH1RE	VA	V1RG1N1A
1L	1LL1NO1S	NJ	NEW JERSEY	WA	WASH1NGTON
1N	1ND1ANA	NM	NEW MEX1CO	WV	WEST V1RG1N1A
1A	1OWA	NY	NEW YORK	W1	W1SCONS1N
KS	KANSAS	NC	NORTH CAROL1NA	WY	WYOM1NG

Countries

AR	ARGENT1NA	1C	1CELAND	PK	PAK1STAN
AS	AUSTRAL1A	1D	1NDONES1A	PN	PANAMA
AZ	AZORES	1N	1ND1A	PO	PORTUGAL
BE	BELG1UM	1T	1TALY	PR	PUERTO R1CO
BC	BR1T1SH COLON1ES	JA	JAPAN	RH	RHODES1A
BR	BRAZ1L	KS	KOREA	SA	SOUTH AFR1CA
CA	CANADA	LE	LEBANON	SN	S1NGAPORE
C1	CH1LE	L1	L1BER1A	SP	SPA1N
CO	COLUMB1A	LU	LUXEMBOURG	CE	SR1 LANKA
CS	COSTA R1CA	MX	MEX1CO	SW	SWEDEN
DA	DENMARK	MY	MALAYS1A	TH	THA1LAND
FR	FRANCE	NL	NETHERLANDS	TU	TURKEY
GE	GERMANY	NO	NORWAY	TW	TA1WAN
GH	GHANA	NZ	NEW ZEALAND	UK	UN1TED K1NGDOM
GR	GREECE	PE	PERU	US	UN1TED STATES
HO	HONDURAS	RP	PH1L1PP1NES	VE	VENEZUELA

Figure 6-1-1.—State and country abbreviations.

Army Regulation AR 105-32 and Air Force Manual AFM 10-4, respectively.

MESSAGE ADDRESSING.—Messages may be addressed to individual commands/activities, in which case each activity's plain language address appears in the address component (e.g., a message from CNO WASHINGTON DC to CINCLANTFLT NORFOLK VA, COMCRUDESLANT NORFOLK VA, etc.); or a message may be addressed to a predetermined group of activities, in which case a Collective Address Designator appears in the address component (e.g., a message from COMNAVELCOM WASHINGTON DC to AIG SIX FOUR or NAVCAMS LANT NORFOLK VA, etc.); or a Collective Address Designator appears in the address component (e.g., a message from COMNAVTELCOM WASHINGTON DC to AIG SIX FOUR or NAVCAMS LANT NORFOLK VA to ALL SHIPS PRESENT HAMPTON ROADS AREA). It may also be the case that one message is addressed to both individual activities and collectives.

A distinction is drawn between addressing messages to separate activities and collectives because addressing procedures are different for each case. Addressing procedures contained below apply to both cases.

From Line.—The From line is the first line of the address component and contains the

originator's complete plain language address. A message must have only one originator. The prosign "FROM" is used on the DD-173 MESSAGEFORM and is preprinted. (See figure 6-1-2).

To Line.—The To line contains the action addressees' plain language address(es). The number of action addressees is not restricted. The prosign "TO" precedes the first addressee's plain language address. (See figure 6-1-2). The prosign "TO" is used on the DD-173 MESSAGEFORM and is preprinted.

Info Line.—The Info line contains the action addressees' plain language address(es). The number of info addressees is not restricted. The prosign "INFO" precedes the first addressee's plain language address. (See figure 6-1-2). The prosign "INFO" is used on the DD-173 MESSAGEFORM and is *not* preprinted. If INFO is to be used it must be typed on the form beginning at tab stop 15 and preceding the first info address.

XMT Line.—When addressing messages to collectives the originator may desire to exempt activities from receiving the message. To accomplish this, the plain language addresses of exempted activities are typed in a column below the last Info addressee. The number of exempted activities is not restricted. The prosign "XMT" precedes the first exempted activity's plain language address. (See figure 6-1-2). The prosign "XMT" is used on the DD-173 MESSAGEFORM and is *not* preprinted. If XMT is to be used it must be typed on the form beginning at tab stop 16 and preceding the first exempt address.

ADDRESSING COMMERCIAL FIRMS.—Only unclassified messages may be transmitted to commercial firms or individuals.

Only plain language designations or registered cable addressees are employed in the address portion of messages filed with a commercial carrier for delivery. Commercial communication companies provide for the registering with their company of short cable addresses. These cable addresses are used as message address designators in lieu of the complete long title and mailing address.

Examples:

1. NIEHL HOUSTON TX
2. DOLDOFF GLASGOW UK
3. MAVAP ST NAZAIRE FR
4. MANIPORT CADIZ SP
5. CONFIDENCE RAS TANURA SA
6. SEABSEA NAHA JA

Messages which do not contain short cable addresses are limited to a maximum of three address lines for each commercial firm or individual. The first line contains the name, the second and third contain the address and are indented five spaces from the beginning of the name in the first line. (See figure 6-1-2).

Messages addressed only to a commercial firm or individual via commercial refile need not carry an SSIC (Standard Subject Identification Code).

ADDRESSING COLLECTIVES.—A collective address is a group of activities which can be addressed using a single plain language address designator. Two forms of collective addresses predominate. One form addresses an administrative or operational group by use of a Collective Address Designator (CAD).

Examples:

1. FOURTH MAW
2. DESRON SIX
3. ALL UNITS HOMEPORTED YOKOSUKA JA
4. TG SEVEN SEVEN PT FOUR

The second form addresses a predetermined list of specific and frequently occurring action and info addressees by use of an Address Indicator Group (AIG).

Examples:

1. AIG SEVEN SIX ZERO EIGHT
2. AIG SEVEN SIX FOUR ONE

JOINT MESSAGEFORM									SECURITY CLASSIFICATION: UNCLASSIFIED		
PAGE	DTG RELEASER TIME			PRECEDENCE		CLASS	SPECAT	LMF	CIC	ORIG MSG IDENT	
	DATE TIME	MONTH	YR	ACT	INFO						
01 OF 01				PP	RR	UUUU				1230200	

BOOK — MESSAGE HANDLING INSTRUCTIONS

FROM NAVOCEANCOMDET ALAMEDA CA

TO AIG SEVEN SIX ZERO EIGHT

INFO NAVOCEANO BAY ST LOUIS MS

DOCS WEATHER CO

2806 CLOUD STREET

PENSACOLA FL 32509

XMT NAVOCEANCOMCEN PEARL HARBOR HI

UNCLAS //N03145//

STORM CONTRACT

A. NAVOCEANCOM INST 3140.1F

B. NAVOCENDET MEMO 222/331 OF 21 MAY 82 NOTAL

1. THE 38KT WINDS YOU HAVE ORDERED WILL NOT BE AVAILABLE UNTIL MID NOVEMBER.

2. TWO SUBSTITUTE STORMS WITH 20KTS IN EACH HAS BEEN SHIPPED AND HOPEFULLY WILL MEET YOUR NEEDS.

6
5
4
3
2
1
0

DISTR

DRAFTER TYPED NAME TITLE OFFICE SYMBOL PHONE
AGAN C. L. SKIES, METRO, 7565

SPECIAL INSTRUCTIONS

RELEASER
TYPED NAME TITLE OFFICE SYMBOL AND PHONE
R. CLOUD, CDR, METRO, 7103

SIGNATURE

SECURITY CLASSIFICATION
UNCLASSIFIED

DATE TIME GROUP

DD FORM 1 MAR 79 173/2 *(OCR)* PREVIOUS EDITION IS OBSOLETE GPO 1979 302-176

209.446

Figure 6-1-2.—Sample OCR message—DD Form 173.

Two environmental AIGs have been established for use, as appropriate, by all U.S. Navy activities and all ships (including USN, U.S. non-Navy and foreign) for requesting environmental services and for reporting environmental observations. The appropriate environmental AIG to be used is dependent on the operating area or area for which services are required.

AIG 7608: For use by all U.S. Navy activities and all ships (including USN, U.S. non-Navy and foreign) operating in or requesting services for the North Pacific, South Pacific, Persian Gulf, and Indian Oceans, including the associated seas and basins, all areas south of 60 degrees S latitude and surrounding land areas.

Example:

1. Action: NAVWESTOCEANCEN PEARL HARBOR HI

   NAVOCEANCOMCEN GUAM

   FLENUMOCEANCEN DATA MONTEREY CA

   Info: AFGWC OFUTT AFB NE

AIG 7641: For use by all U.S. Navy activities and all ships (including USN, U.S. non-Navy and foreign) operating in or requesting services for the North and South Atlantic Oceans, Gulf of Mexico, the North, Norwegian, Baltic, Red, Mediterranean and Caribbean Seas, all areas north of 60 degrees N latitude, the Great Lakes and surrounding land areas.

Example:

1. Action: NAVOCEANCOMCEN ROTA SP

   NAVEASTOCEANCEN NORFOLK VA

   FLENUMOCEANCEN DATA MONTEREY CA

   Info: AFGWC OFUTT AFB NE

For more detailed information on environmental AIGs refer to the U.S. Navy Meteorological and Oceanographic Support Manual, NAVOCEANCOMINST 3140.1( ).

Text Components

CLASSIFICATION LINE.—The classification line is the first line of the text. It must contain the message's classification, and when applicable, special handling markings, code or flag words and the *Standard Subject Identification Code (SICC).*

The first word of the classification line must be one of the three classification designators or the word UNCLAS. For U.S. use, the three classification designators are CONFIDENTIAL, SECRET, and TOP SECRET. The acronyms FOUO, which means For Official Use Only, and EFTO, which means Encrypt for Transmission Only, are not classification designators per se, yet they are used with UNCLAS in the classification line. Likewise, the terms Restricted Data and Formerly Restricted Data, while not classifications in themselves, are used with classification designators. The proper spelling and spacing of classification designators is displayed below:

UNCLAS

UNCLAS E F T O FOUO

C O N F I D E N T I A L

S E C R E T

T O P S E C R E T

FOUO and EFTO.—Unclassified messages, which meet the criteria of SECNAVINST 5720.42( ), will be designated For Official Use Only (FOUO), and handled in accordance with SECNAVINST 5570.2( ). The classification line of such a message will read: "UNCLAS FOUO."

The caveat EFTO is a special handling designation which means Encrypt For Transmission

Only and is not required in the classification line of unclassified messages addressed exclusively among Navy and Marine Corps commands. The only time EFTO markings are required is when Navy and Marine Corps unclassified messages are marked FOUO and are addressed to a DOD activity outside CONUS and not part of the Navy and Marine Corps. The classification line of these messages will read: "UNCLAS E F T O FOUO."

Restricted Data and Formerly Restricted Data.—Classified messages which conform to the criteria outlined in OPNAVINST 5510.1F are designated Restricted Data or Formerly Restricted Data. The classification line of such a message (assuming a CONFIDENTIAL classification) would read: C O N F I D E N T I A L FORMERLY RESTRICTED DATA or C O N F I D E N T I A L RESTRICTED DATA.

Special Handling Markings.—Certain types of messages require special handling in addition to that provided by the security classification. Markings which indicate special handling requirements are placed in the classification line immediately following the classification. A broad discussion of special handling procedures is contained in NTP 4.

Standard Subject Identification Code (SICC).—The SSIC is the last element of the classification line, and is required on all Navy originated messages except as noted in NTP 3.

The six character code which is derived from SECNAVINST 5210.11( ), is preceded and followed by two slant lines (e.g., //N03144//). Messages which do not carry an SSIC are returned to the drafter by the message center. (See figure 6-1-2).

The SSIC is used as one method for determining internal message distribution. Incorrect or very general SSICs only serve to defeat message processing aids. Care must be exercised in selecting an SSIC which most completely and accurately corresponds to the message subject matter.

Examples:

1. OBSERVATIONS //N03144//
2. FORECASTS, WARNINGS, AND ADVISORIES //N03145//
3. CLIMATOLOGY //N03146//
4. OTSR //N03148//
5. OCEANOGRAPHIC PRODUCTS //N03160//

SUBJECT LINE.—The subject line begins at the left-hand margin of the first line following the classification line (or following the passing instructions line when used). (See figure 6-1-2).

Message subject lines are keys to the reader as to the basic contents of the message text. Concurrently, internal message routers and Navy Automated message processing systems key on the subject line in order to determine internal message distribution. Therefore, messages containing similar information should be assigned a standard subject whenever practicable in order to facilitate message identification and internal distribution.

The subject line may be omitted from tactical messages that are *pro forma*, or when its use will cause an otherwise unclassified message to be classified, when its use will noticeably increase the length of a short message, or if the subject is readily apparent in the first line of text.

REFERENCE LINE.—Reference lines are employed as an alternative to repeating lengthy references within the text of a message. Any identifiable document, all messages, and telephone conversations may be referenced in a message providing that the reference line is clear and sufficiently specific. Each reference is lettered consecutively, one beneath the other. (See figure 6-1-2).

Documents.—The complete, abbreviated title, edition and relevant sections or paragraphs must be cited in the reference.

Example:

1. A. SECNAVINST 5720.42A PARA 8(A)

   B. NTP 4( ) Art. 01.03.0220

Correspondence.—The short title portion of the originator's plain language address, the serial number, and the date of the correspondence must be cited in the reference.

Example:

1. A. CNO LTR 376/941 OF 27 FEB 81

   B. COMNAVTELCOM MEMO 117/331 OF 16 JUN 81

Messages.—Telecommunications centers, as a rule, route incoming messages according to references. For example, if COMNAVOCEAN-COM received a message from CNO which referenced a previous COMNAVOCEANCOM message, the CNO message would receive the same internal routing as did the referenced message. In a manually-operated message center, reference routing is done by communicators who screen incoming traffic; however, reference routing is performed automatically by the Navy's two automated message processing systems, the LDMX and NAVCOMPARS. These systems recognize either "MY" or the originator's complete plain language address; therefore, both are authorized for use by message drafters.

Example:

1. A. MY 131927Z SEP 82

   B. COMNAVOCEANCOM WASHING-TON DC 131927Z SEP 82

Similarly, in the case of single action addressee messages, the LDMX and NAVCOMPARS recognize either "YOUR" or the originator's complete plain language address; therefore, the use of both are authorized.

Example:

1. A. YOUR 141946Z SEP 82

   B. CNO WASHINGTON DC 141946Z SEP 82 ALCOM 023/82

   C. NAVOCEANCOMDET 120046Z OCT 82

With multiple action addressees, it is mandatory that message drafters construct message reference lines citing the originator's complete plain language address in lieu of "YOUR", then the date-time-group, month and year exactly as they appear on the message to be referenced.

Communications facilities maintain message files for a period of 60 days. Therefore, if it is necessary to refer to messages older than two months, message originators should either summarize essential information or readdress the message using the action office copy, by typing the entire message to be readdressed (in readdressal format) on a DD-173. Message readdressal is covered in detail in NTP 3.

NOTE: General messages *will not* be referenced by the use of "MY" or "YOUR." The general message title and serial number are added to the reference after the date-time-group.

Example:

1. A. COMNAVTELCOM WASHINGTON DC 082131Z MAR 81 ALCOM 008/81

   B. CNO WASHINGTON DC 181723Z JUL 81 NAVOP 045/81

NOTAL and PASEP.—It is frequently necessary, particularly in the case of multiple-address messages, to reference a document or message which some or all of the addressees do

not hold. In such cases NOTAL, which means not to nor needed by all, is appended to the reference.

Example:

1\. A. CNO WASHINGTON DC 131826Z NOV 80 NOTAL

B. NAVTELSYSIC CHELTENHAM MD 211317Z MAR 81 NOTAL

The prosign PASEP, which means "Passed Separately", is appended to a reference which has been passed by separate means to all addressees of the message in which reference is being made.

Example:

1\. A. CINCPACFLT PEARL HARBOR HI 142313Z DEC 81 PASEP

B. NAVTELSYSIC CHELTENHAM MD 181723Z APR 81 PASEP

The prosigns PASEP NOTAL is appended to a reference which has been passed by separate means to at least one, but not all, addresses of the message in which reference is being made.

Example:

1\. A. COMSIXTHFLT 181615Z JAN 81 PASEP NOTAL

Telephone Conversations.—Telephone conversation references are not used in the automated message routing process. However, they can be used as discussed previously.

Example:

1\. A. PHONCON COMNAVTELCOM CAPT SMITH/USS MIDWAY CDR BOYLES OF 25 MAY 81

TEXT FORMAT.—The text is that part of the message which contains the thought or idea the drafter desires to communicate; it is the reason for the existence of all other parts of the message. Brevity is essential, but must not be attained at the cost of accuracy; rather, brevity is achieved through the proper choice of words and good writing technique. Uncommon phrases and modes of expression must not be carried to the point that the meaning becomes ambiguous or obscure.

As the drafter you must word a message so that it expresses unmistakably the thought you desire to convey. Abbreviations must be limited to those meanings which are self-evident, or which are recognizable by virtue of long established use. Exceptions may be made in the case of currently authorized abbreviations used in routine administrative and technical traffic which is handled only by persons familiar with the abbreviations such as the synoptic code.

In cases of doubt, the rule should be that clarity always takes precedence over brevity.

Indenting.—The classification, passing instructions, subject, and reference lines always begin at tab 6. When necessary for graphic clarity, textual material may be indented as many as twenty spaces.

Paragraph Numbering.—Frequently, messages must address several subjects or several aspects of one subject. For this reason, material is divided into paragraphs, subparagraphs, and summary paragraphs which are numbered and lettered consecutively, respectively.

Single paragraph messages need not be numbered.

Punctuating.—Within the text of a message, punctuation is used when essential for clarity. Punctuation marks are limited to those in normal use. Punctuation marks must be processed and transmitted exactly as drafted, provided the method of transmission and the cryptosystem permits. Otherwise, communications personnel might substitute authorized abbreviations or spell out the punctuation mark.

CLASSIFICATION MARKINGS

1. Subject line.—The subject line of a classified message must be marked with the appropriate parenthetical classification symbol if the subject line contains classified information. If the subject line of a classified message is unclassified, it must be so marked. For both cases, the appropriate parenthetical symbol follows the subject line.

Example:

1. HDT SPECTURAL ANALYSIS (S) *for illustration only*

2. Paragraph.—OPNAVINST 5510.1( ) requires that each paragraph or subparagraph of classified messages are marked to show the level of classification, or that the paragraph, or subparagraph is unclassified.

The classification of the text of the lead-in portion of a paragraph is to indicated at the beginning of the text with the appropriate parenthetical symbol. The parenthetical symbols "(TS)" for Top Secret, "(S)" for Secret, "(C)" for Confidential, and "(U)" for Unclassified, shall be used. The classification of subparagraphs shall be shown by the appropriate parenthetical symbol immediately following the subparagraph letter or number. In the absence of letters or numbers, the classification must be shown immediately before the beginning of the paragraph or subparagraph.

Examples:

1. (U) THIS IS THE LEAD-IN WHICH IS UNCLASSIFIED.
   (1) (C) THIS SUBPARAGRAPH IS CONFIDENTIAL.
      (a.) (S) THIS SUBPARAGRAPH IS SECRET.

3. Page.—Classified messages are marked at the top and bottom of each page with the ***highest*** assigned classification. When a message is printed by an automated system, the classification markings may be applied by that system, provided the markings are made clearly distinguishable from the printed text.

4. Downgrading and Declassification.—Downgrading and declassification markings must be applied to all classified messages (except those addressed only to foreign addressees). They are typed at the left-hand margin on the first line after the last line of text.

Examples:

1. DECL____________________ See Note 1
2. REVW____________________ See Note 2
3. DG/____________________ See Note 3

Notes:

1. Insert day, month, and year for declassification, e.g., 6 JUN 99.
2. Insert day, month, and year for declassification review, e.g., 6 JUN 89.
3. Insert "S" or "C" and specific date of event e.g., DG/C/6 JUN 93.

General information on the downgrading and declassification system is contained in OPNAVINST 5510.1F Department of the Navy information security program regulation.

NOTE: Messages Containing Time Sensitive Information.—When the text of a message contains time sensitive information which becomes obsolete by a certain time, the drafter must insert the Operating Signal (OPSIG) "ZPW", date, time, month, and year in the Message Handling Instructions block.

EXERCISE (6-1-1)

1. List four categories of precedence used in naval messages and their prosign as it is used on DD-173.

   (a) ____________________ ____________

   (b) ____________________ ____________

   (c) ____________________ ____________

   (d) ____________________ ____________

   (Any order)

2. What is the basic rule of punctuation for addressing naval messages?

   ____

   ____

3. Give an example of each type of collective address.

   (a) ____

   (b) ____

4. How do the classifications UNCLAS and SECRET appear in the classification line of a message?

   (a) ____

   (b) ____

5. Which of the following SSICs is correct?

   (a) //N3145//
   (b) //N03148
   (c) //N0 3160//
   (d) //N03144//

6. What must precede each paragraph of a classified multiparagraph message?

   ____

   ____

   ____

Typing Naval Messages

The computers have "jumped" into our lives bringing with them many wonderful capabilities and time-saving services. Modern communications use computers and electronic scanning devices to read and transmit naval messages. Many strict guidelines must be followed, when typing a naval message, to ensure acceptance by the optical character reader (OCR) and to expedite the transmission of the message.

FORMS.—As mentioned previously, the joint messageform DD-173, is the only acceptable form for naval messages. These forms are available through the Naval Supply System in two colors—red or light blue. The color a particular activity must use is determined by the type of OCR equipment used in the serving telecommunications center.

Locally reproduced copies of the DD-173 MESSAGEFORM *cannot* be used as they cannot be processed by the OCR.

TYPEWRITERS AND SYMBOLS.—Special equipment is required for typing messages on the DD-173 MESSAGEFORM. SECNAV Instruction 10460.9B contains specifications for and a list of approved OCR typewriters and carbon-type ribbons. Equipment specified in this instruction must be used in typing messages on the DD-173 MESSAGEFORM. Additionally, it is essential that typewriters and fonts be well maintained to ensure production of dark, clear characters.

AUTHORIZED SYMBOLS.—All letters and numbers and only certain abstract symbols can be typed on DD-173 MESSAGEFORMS. The authorized symbols are displayed below:

-	Dash	:	Colon
.	Period	ⁿ	Quotation Mark
¬	Comma	▮	Blob (Character Erase)
?	Question Mark	ɾ	Hook
/	Slant	|	Vertical Line
{	Open Parenthesis	—	Group Erase (Erase Complete Line)
ч	Fork		
}	Close Parenthesis		

NOTE: The Group Erase symbol is an elongated horizontal line (not a hyphen or underline character) that prints across the center of a character. For example, an IBM Selectric II typewriter and an ASA OCR font, the group erase symbol is printed by typing an uppercase "R". The symbol used to form an unbroken line through the first tab stops of the line to be erased.

ALIGNMENT, MARGINS, AND SPACING.—Messages typed on the DD-173 MESSAGEFORM enter the telecommunications system through an OCR which is programmed to process certain groups of characters at specific locations on the message form. If the form is misaligned before typing, or if the spacing or margins do not conform to programmed requirements, then the OCR does not find the correct characters at the designated locations and the message is not entered into the telecommunications system.

Alignment.—There are two extended horizontal lines in the upper left- and right-hand margins of the DD-173 MESSAGEFORMS which must be used as guides to obtain proper alignment. (See figure 6-1-3). Prior to typing any part of the message, adjust the form in the typewriter carriage so that a typed character can be printed between these lines. These alignment characters *must* be eliminated prior to entering the message into the Optical Scanning Unit (OSU)/Optical Character Reader (OCR); only one thickness of adhesive correction tape or carbon film lift-off correction may be used.

Margins.—Set the typewriter paper guide at 0. Set the left margin at 6. Set the right margin at 75. These margin settings allow 69 spaces or characters per line maximum, and this limit must not be exceeded.

At the lower left-hand side of the form, there is a series of numbers which act as the form length guide. The last line of the text must not be below the last number

JOINT MESSAGEFORM

SECURITY CLASSIFICATION: UNCLASSIFIED

PAGE	DTG RELEASER TIME: DATE TIME	MONTH	YR	PRECEDENCE: ACT	INFO	CLASS	SPECAT	LMF	CIC	ORIG. MSG IDENT
01 OF 01				PP	RR	UUUU				1030200

BOOK | MESSAGE HANDLING INSTRUCTIONS

FROM COMNAVOCEANCOM WASHINGTON DC

TO: CNO WASHINGTON DC

UNCLAS //N02309//

ALIGNMENT SPACING AND MARGINS

A. NTP 3 SECTION 02

1. THE ARROWS ABOVE POINT TO THE PAIR OF HORIZONTAL LINES WHICH MUST BE USED AS ALIGNMENT GUIDES FOR TYPING MESSAGES ON DD-173 MESSAGE FORMS.

2. PRIOR TO TYPING ANY PART OF THE MESSAGE, ADJUST THE FORM IN THE TYPEWRITER CARRIAGE SO THAT A CHARACTER WILL PRINT BETWEEN THESE LINES. THIS CHARACTER MUST BE COVERED OVER WITH CORRECTION TAPE OR CARBON FILM LIFT-OFF CORRECTION TAPE.

3. ONCE THIS ADJUSTMENT HAS BEEN MADE, DO NOT REALIGN THE FORM. DO NOT REMOVE THE FORM FROM THE TYPEWRITER FOR CORRECTIONS, THEN ATTEMPT TO REALIGN.

4. THE ARROW BELOW POINTS TO THE FORM LENGTH GUIDE. THE LAST LINE OF THE TEXT MUST NOT BE BELOW THE LAST NUMBER IN THE SERIES WHICH IS 0. THIS WILL ENABLE YOU TO TYPE TWENTY LINES PER PAGE.

5. TYPING WITHIN THE VARIOUS BLOCKS AND COMPONENTS OF THE FORM BEGINS AT THE TABULATION STOPS SET FORTH IN FIGURE 6-1-4.

DISTR

DRAFTER TYPED NAME TITLE OFFICE SYMBOL PHONE: AGCS W. D. FERNALD, 3225, 20547

4-12-82

SPECIAL INSTRUCTIONS

RELEASER — TYPED NAME TITLE OFFICE SYMBOL AND PHONE: G. JONES, LCDR, 322, 20548

SIGNATURE

SECURITY CLASSIFICATION: UNCLASSIFIED | DATE TIME GROUP

DD FORM MAR 79 173/2 (OCR) PREVIOUS EDITION IS OBSOLETE GPO 1979 302-176

209.446

Figure 6-1-3.—Alignment, spacing and margins.

in the series which is 0 (a total of twenty lines counting from the "FROM" Line). (See figure 6-1-3).

Spacing.—All typing entries in the header lines, address component, text and distribution block and components of the form begins at the tabulation stops set forth in figure 6-1-4.

TYPING ERRORS.—Typing errors cannot be erased. If a typing error is made in the headerlines, it can be corrected using self-adhesive correction tape (only one thickness) or the correcting function of the IBM Selectric II typewriter. If a typing error is made on any other part of the message form, it can be corrected using either of the two methods above, or it can be struck over with the character erase

	Data Field	Tab Stop	Requirement; Notes
Line 1	Page number	06	all pages
	Page count	10	last page (1)
	Date-time	14	first page only (assigned by Commcen)
	Month	23	first page only (assigned by Commcen)
	Year	28	first page only (assigned by Commcen)
	ACT precedence	32	all pages
	INFO precedence	36	optional (2)
	Classification	40	all pages
	SPECAT	46	optional (3)
	LMF	53	optional (4)
	CIC	57	optional (4)
	ORIG/MSG IDENT	63	(5)
Line 2	Book	06	optional (YES or blank)
	Message Handling	11	OPSIGs optional; DDI's required for DSSCS (6)
Line 3	Originator PLA	20	(7)
Line 4 and below	PLA without prosign	20	(7)
	Prosign INFO	15	(7)
	Prosign LESS	15	Used for DSSCS
	Prosign XMT	16	(7)
	OPSIG ZEN	20	
	PLA continuation lines	25	(8)
	Classification	06	(9)
	QQQQ	06	(10)
	Accounting Symbol	15	(11)

Notes:

(1) Need only appear on last page. If used on other pages must be consistent.
(2) INFO precedence will be left blank on single precedence messages.
(3) If used, must appear on all pages.
(4) If used, need appear only on page 01.
(5) Required on all pages of DSSCS and GENSER messages and will be the same on all pages.
(6) If OPSIGs are used on a DSSCS message, DDI's must follow the OPSIGs. DDI's required only on DSSCS messages. DDI's are not permitted at GENSER only sites.
(7) All PLAs begin at tab stop 20. Office symbols will be delimited by double slants following PLAs.
(8) All continuation lines begin at tab stop 25.
(9) Classification followed by handling caveats on same line.
(10) End-of-classification indicator required on next line after classification and handling caveats. Required at DSSCS and DSSCS/GENSER sites. Not to be used at GENSER sites only.
(11) See Paragraph 02.03.0700

Figure 6-1-4.—Tabulation stops.

symbol "blob" and the correct character then typed in the following space. For example, if the word "DATA" was typed "DAH" it would appear corrected as "DA TA." To delete an entire line from the message, strike over the first three characters of the line with the "Group Erase" symbol.

BLOCKS.—The page block contains four numeric characters divided into two sets; page number and total number of pages. The page number is required on each page. The total number of pages is required only on the last page, and may be omitted on all previous pages. However, if the total number of pages is given on other than the last page, it must be consistent (identical with the last page). A single page message would thus contain '01 of 01' in the page block. The page blocks of a three page message would contain either '01 of 03' '02 of 03' and '03 of 03'; or '01 of ', '02 of ', and '03 of 03'. (See figure 6-1-3).

DTG RELEASE TIME.—This block contains a date and time assigned by the serving communication (COMM) center and is left blank by the drafter. The date and time is expressed in Greenwich Mean Time and is used as the Date-Time-Group. The first two digits represent the day of the month, the next two digits represent the hour using a standard 24-hour clock, and the last two the minute. The date and time are appended with the letter "Z". The month is expressed by using the first three letters of the month. For the year use the last two digits of the current year. The date-time-group is required only on the first page of all messages.

PRECEDENCE.—The precedence typed in the Action and Info blocks must each be two letter codes. These codes are displayed in figure 6-1-5. The action precedence is required on all pages of a multiple page message. The precedence typed in the Info block cannot be higher than that typed in the Action block. Unless the message is dual precedence the info block is left blank. When there are only Info addressee(s) the precedence assigned to the message is placed in the Action block only.

Precedence	Two Letter Code
Emergency	YY
Flash	ZZ
Immediate	OO
Priority	PP
Routine	RR

TWO LETTER PRECEDENCE CODES

Classification	Four Letter Redundancy
Top Secret	TTTT
Secret	SSSS
Confidential	CCCC
Unclassified	UUUU
Unclassified EFTO	EEEE

Figure 6-1-5.—Four letter redundancy codes.

Classification (CLASS).—The entry in this block must be a four-character, security redundancy code. These codes are displayed in Figure 6-1-5. The classification block *must* be filled in on all pages of a multiple page message.

Special Category (SPECAT).—Because of their content, certain messages must be designated SPECAT and contain a SPECAT Release Code (SRC) or, in some instances, may require a Special Handling Designator (SHD). When either (SRC) or (SHD) is required, it is placed in the SPECAT block and repeated five times.

Language Media Format (LMF) and Content Indicator Code (CIC).—Leave blank except where specifically required for certain reports such as Nuclear Weapons, MILSTRIPs and DEIS reports.

Originator/Message Identification (ORIG/MSG IDENT).—Message drafters should assign a seven digit (Julian) time of file in this block, and on all pages of a multi-page message. It must be the same on all pages.

Book Message.—To indicate that a book message *must* be delivered to each addressee as

a single message, place the word "YES" in the Book Block on the DD-173 MESSAGEFORM. Automated message processing systems generate the operating signal "ZYQ" based on "YES" in the Book Block.

Message Handling Instruction.—This block is used by message drafters to indicate that a message has unique processing requirements. All entries in this block should begin at tab stop 11.

Messages that are perishable and should not be processed after a specified time. The Operating Signal "ZPW" means, "This message cancelled at time indicated. Do not make further transmission." The LDMX/NAVCOMPARS is programmed to recognize the Operating Signal ZPW, expiration date, time, month and year and inhibit further transmission. The use of "ZPW" procedures by drafters prevent unnecessary transmission/retransmissions of information which is no longer valid or which has been superseded such as forecasts and warnings.

Example:

1. ZPW 302359Z APR 85

"ZPW" means the information is perishable and "302359Z APR 85" indicates the exact time at which the information becomes obsolete.

MULTIPLE PAGE MESSAGE.—There is a limit to the number of pages which can be used in the preparation of messages on the DD-173 MESSAGEFORM. The standard LDMX/NAVCOMPARS common software is capable of processing a 28 page message. The DD-173 MESSAGEFORM is used for the first and all subsequent pages (i.e., there is no "continuation page" form). When using a DD-173 MESSAGEFORM as a continuation sheet, complete the page, precedence, classification, and ORIG/MSG IDENT blocks. All (except the page block) contain the same information on each page of the message.

Message Parts.—NAVCOMPARS and AUTODIN are capable of accepting continuous transmission of up to 40,000 message characters. Accordingly, when preparing messages for entry to NAVCOMPARS, directly or via AUTODIN, commands/units may transmit up to 550 continuous lines (28 OCR pages) of message headings and texts.

Commands/units preparing messages exceeding 40,000 characters or 550 lines (28 OCR pages) are required to divide the message into two or more separate parts.

1. Plain language address. OCR equipped, automated message processing systems route outgoing traffic based on a scan of the addresses in the address component. Because of this, it is necessary that the command short titles and geographic locations typed in the address component correspond exactly to the titles and geographic locations stored in the processing system's memory. The phrase used to denote a command's short title and location together, used for message addressing, is "plain language address" (PLA). Section 01 of NTP 3 SUPP-1 contains the Plain Language Address Directory (PLAD). The PLAD is a listing of approved Navy, Marine Corps and Coast Guard plain language addresses. Plain language addresses typed in the address component must conform to those contained in the PLAD. They must be typed on the message form exactly as they appear in the PLAD. Do not add any characters or any form of punctuation. Navy PLA's must not exceed 50 characters.

2. From Line. The action addressees' plain language addresses must be at tab stop 20. The originator's PLA must not exceed fifty characters including spaces. A continuation line cannot be used.

3. To Line. The action addressees' plain language addresses must begin at tab stop 20. Unlike the From line, continuation lines can be used for action, info and exempt addressees when their PLAs are longer than fifty characters or spaces.

When using a continuation line, type the first fifty characters or spaces on the first line; then beginning at tab stop 25 of the next double-spaced line, type the remaining characters. This procedures can be repeated as many times as

necessary. Do not use any form of punctuation to indicate that the PLA has been broken between two or more lines. Succeeding addressees begin at tab stop 20.

4. Info Line. The first information addressee must be preceded by the prosign INFO on the first double-spaced line below the last action addressee. If there are no action addressees, type the first information addressee on the To line, preceded by the prosign "INFO." In both cases, the prosign starts at tab stop 15 and is typed only once (i.e., the prosign must not be typed for succeeding information addressees, only the first). All information addressees' plain language addresses begin at tab stop 20. If more than one line is required for an addressee's PLA, use the continuation line procedure outlined above.

5. Exempting Addressees. When using collective (e.g., DESRON FIVE, TG SIX ZERO PT TWO, AIG SIX FOUR) originators may want to exempt some elements in the collective from receiving the message. To do this, type the prosign "XMT" on the first double-spaced line below the last addressee, starting at tab stop 16. Then starting at tab stop 20, list the full plain language addresses of the exempted addressees. (See figure 6-1-2.)

6. Accounting Symbols/Program Designator Codes for Addressing Commercial Firms and Private Individuals. Accounting symbols and program designator codes (PDCs) are arbitrary combinations of letters assigned to most authorized users of U.S. military communications when messages require transmission entirely or partially via commercial communications systems. The accounting symbol for Navy/Marine CORPS originated messages (NA-CNRF) and for COAST GUARD originated messages (CG-W2GX) are placed in format line 10 of the DD-173 MESSAGEFORM, which is the next double-spaced line below the last addressee (or XMT addressee). They will be preceded by the abbreviation "ACCT" beginning at tab stop 15. Thus, format line 10 for a NAVY/MARINE CORPS message would be "ACCT NA-CNRF" and for a COAST GUARD message, "ACCT CG-W2GX".

When addressing a message to a commercial firm or individual, use no more than three lines for each addressee. The first line contains the name and begins at tab stop 20. The second and third lines contain the address and begin at tab stop 25. An SSIC need not be used. Only classified messages may be addressed to commercial firms or individuals.

7. Classification Line. The first line of the text, which is the classification line, begins one double-spaced line down from the last accounting symbol, or last addressee, if there are no accounting symbols, or if beginning a new page, starts on the "From" line of the next page. The first line of the text must contain the message's classification, special handling instructions, code or flag words, and the Standard Subject Identification Code (SSIC). The first word of the classification line must be the classification and this must agree with the four character security redundancy code in the Class block. Space must be left between characters in the classification precisely as illustrated below:

UNCLAS

UNCLAS   E F T O   FOUO

C O N F I D E N T I A L

S E C R E T

T O P   S E C R E T

The Standard Subject Identification Code (SSIC), preceded by one or two spaces, follows the classification and special handling instructions. The six character code, which is derived from SECNAV Instruction 5210.11( ), is preceded and followed by two slants.

8. Passing Instructions. Passing instructions are to be typed consecutively, beginning at tab stop 6, one double-spaced line below the classification line.

9. Subject Line. The subject line begins at tab stop 6, one double-spaced line below the last element of the classification line or when using passing instructions, one

double-spaced line below the last instruction. (See figure 6-1-6).

10. Reference Line. Telecommunications centers, as a rule, route incoming messages according to the message references. For example, if COMNAVTELCOM received a message from CINCLANTFLT, and the CINCLANTFLT message referenced a previous COMNAVTELCOM message, the CINCLANTFLT message would be routed to the office within COMNAVTELCOM which originated the referenced message. LDMX and NAVCOMPARS, by maintaining a computerized file of all outgoing messages, are able to perform reference routing automatically. To accomplish this, however, it is mandatory that message drafters construct message reference lines exactly as indicated below.

The first reference line begins at tab stop 6, one double-spaced line below the subject line (or one double-spaced line below the classification line or passing instructions if there is no subject line). Each reference is lettered consecutively, one beneath the other. Cite first the originator's complete plain language address, then the date-time group, month, and year. (See figure 6-1-6).

11. Text. Text paragraphs are numbered consecutively. Each number is followed by a period. Where necessary for graphic clarity, text lines may be indented a maximum of twenty spaces.

12. Classification Markings.

a. Subject line. The subject line of a classified message must be marked with the appropriate symbol for classification if the subject line contains classified information. If the subject line itself is unclassified, it must be so marked. For both cases, the appropriate symbol enclosed by parenthesis follows the subject line. (See figure 6-1-6).

b. Paragraph. OPNAVINST 5510.1F requires that each paragraph or subparagraph of classified messages be marked to show the level of classification, or that the paragraph or subparagraph be marked as unclassified. (See figure 6-1-6). The following symbols are used to mark subject lines and paragraphs:

Classification	Marking Symbol
Unclassified	(U)
For Official Use Only	(FOUO)
Confidential	(C)
Secret	(S)
Top Secret	(TS)
Restricted Data	(RD)
Formerly Restricted Data	(FRD)
NOFORN	(NOFORN)

c. Downgrading and Declassification. Downgrading and declassification markings are typed beginning at tab stop 6, one double-spaced line below the last line of the text. (See figure 6-1-6).

Examples:

1. DECL____________________ See Note 1
2. REVW____________________ See Note 2
3. DG/____________/________ See Note 3

Notes:

1. Insert day, month, and year for declassification, e.g., 6 JUN 99.
2. Insert day, month, and year for declassification review, e.g. 6 JUN 89.
3. Insert "S" or "C" and specific date or event, e.g. DG/C/6 JUN 93.

13. Blocks.

a. Special Instruction. When a minimize has been imposed, the caveat, MINIMIZE CONSIDERED, is typed in the special instruction block. (See figure 6-1-6).

b. Distribution. Information in this block is to begin at tab stop 6 and consists of the office symbols/activities to which internal distribution (comeback) is to be made by the telecommunications center. Where the OCRE is used in conjunction with a processor that is designed to automatically provide local distribution, each office symbol or activity title is preceded by a vertical line symbol. A maximum of two lines of office symbols is authorized for this block. The maximum length of each group of office symbols is 12 characters. Local distribution is only placed on page one of the message.

JOINT MESSAGEFORM	SECURITY CLASSIFICATION CONFIDENTIAL

PAGE	DTG RELEASER TIME: DATE TIME	MONTH	YR	PRECEDENCE: ACT	INFO	CLASS	SPECAT	LMF	CIC	ORIG/MSG IDENT
01 OF 01				PP		CCCC				1030200

BOOK | MESSAGE HANDLING INSTRUCTIONS

FROM COMNAVOCEANCOM WASHINGTON DC

TO CNO WASHINGTON DC

CINCLANTFLT NORFOLK VA

C O N F I D E N T I A L //N02309//

CLASSIFICATION LINE AND TEXT (U)

A. NTP 3 SECTION 02

B. COMNAVOCEANCOM WASHINGTON DC 210830Z MAR 80

1. (U) THIS MESSAGE ILLUSTRATES CORRECT CONSTRUCTION AND TYPING OF THE TEXT COMPONENT OF DD-173 MESSAGE FORMS AS REQUIRED BY REF A, ARTICLES 02.04.0100 THRU 02.04.0700. NOTE THE FOLLOWING:

A. (U) SEQUENCE OF TEXT ELEMENTS

B. (C) CLASSIFICATION MARKING OF SUBJECT LINE, PARAGRAPHS AND SUBPARAGRAPHS.

C. (U) PLACEMENT OF THE DOWNGRADING INSTRUCTIONS.

2. (U) REF B ILLUSTRATES CORRECT CONSTRUCTION OF MESSAGE REFERENCES. NOTE: THE COMPLETE PLAIN LANGUAGE ADDRESS AND DATE-TIME-GROUP, MONTH AND YEAR ARE CITED IN THE REFERENCE LINE.

DECL 13 APR 86

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DISTR

DRAFTER TYPED NAME TITLE OFFICE SYMBOL PHONE
AGCS I. H. FERNALD, 3225, 20547
4-12-82

SPECIAL INSTRUCTIONS
MINIMIZE CONSIDERED

RELEASER TYPED NAME TITLE OFFICE SYMBOL AND PHONE
G. RAIN, LCDR, 322, 20548

SIGNATURE

SECURITY CLASSIFICATION
CONFIDENTIAL

DATE TIME GROUP

DD FORM MAR 79 173/2 (OCR) PREVIOUS EDITION IS OBSOLETE GPO: 1979 — 302-170

209.446

Figure 6-1-6.—Classification and text.

c. Drafter. Beginning at tab stop 6, one double-spaced line down from the second line of the Distribution block, type the name, rank, and telephone number and office code of the drafter and the present date. No portion of the drafter's signature should extend into the Distribution block. (See figure 6-1-6).

d. Releaser. Unless the drafting office is certain who will release the message, this block should be left blank. Otherwise, type in the appropriate information. No portion of the releaser's signature may extend into the Distribution block. (See figure 6-1-6).

e. Security Classification. For classified messages, stamp or type the message's classification at the top and bottom of each page of the message form. If unclassified, the word "UNCLASSIFIED" may be typed in both places. (See figure 6-1-6).

MESSAGE QUALITY CONTROL

Communications Improvement Memorandums (CIMs)

A Communications Improvement Memorandum (CIM) is an official document used to inform message drafters, releasers and processors of message drafting and/or procedural errors.

CIMs are generated as after-the-fact training aids. Although they should be brought to command attention, they are not intended to be used for punitive action. Their purpose is to create an awareness of proper message procedures so as to prevent recurrence of errors, thereby improving communications service.

A CIM program will be conducted by each Naval Telecommunications Center/Message Center afloat and ashore. CIMs may be handled individually or consolidated to cover a common error made by many activities. The communications officer is responsible to the Commanding Officer for the proper administration of the CIM program. CIMs can be originated by any communications activity and may be in either letter or message format.

Upon receipt of a CIM, message drafters, releasers and processors review the referenced publication and become familiar with the proper procedure/format violated. This review should decrease the possibility of recurrence and increase the speed and efficiency of future communications service.

EXERCISE (6-1-2)

1. How is the DD-173 MESSAGEFORM aligned in the typewriter?

____

____

____

2. What does the operational signal "ZPW" mean?

____

____

3. Which of the following examples are correct for a message which is declassified on 21 MAY 1983?

(a) DECLAS 21MAY83
(b) DECL 21/5/83
(c) DECLAS 21MAY1983
(d) DECL 21 MAY 83

4. If your ship or station is under "MINIMIZE" and your message must be be sent out, what entry is required in the special instruction block?

(a) URGENT TRAFFIC
(b) MINIMIZE, CONSIDERED CRITICAL
(c) MINIMIZE CONSIDERED
(d) MINIMIZE CRITICAL

DRAFTING NAVAL MESSAGES

As an aspiring AG you are frequently called upon to draft a naval message. These messages are not as complex as those drafted by the chiefs or officers. However, they are equally important in their content and function. The shipboard AG drafts surface and upper air observation messages. At shore stations, the AG drafts forecasts and weather warning messages. (See figure 6-1-7 and 6-1-8.)

Drafter Responsibilities

The drafter is the person who composes the message. Among all personnel involved with message management, the drafter is the key to an effective program. The drafter necessarily must have the most detailed knowledge and understanding of the procedures contained in NTP 3. The drafter is responsible for:

Proper addressing.

Clear, concise composition.

Proper application of security classification, special handling, and declassification markings required by OPNAVINST 5510.1( ); also for ensuring that adequate records are maintained to show the source of derivative classification assigned.

Selection of the appropriate precedence.

Coordination of message staffing.

Ensuring that the message is correctly formatted and error free.

Message Drafters/Typists Checklist

The following checklist is recommended for use by message drafters when preparing a message on a DD-173 MESSAGEFORM.

1. Correct page numbering.
2. Precedence.
3. Classification.
4. Valid Short Title. Complete/correct geographical location.
5. Numerical designations spelled out in address.
6. Correct placement of "FROM/TO/INFO/XMT" addee lines.
7. Correct *SSIC*. Do not rely on reference message.
8. Passing instructions appear in text immediately below the classification (if applicable).
9. Subject line.
10. Downgrading instructions indicated IAW OPNAVINST 5510.1. Drafter's responsibility.
11. Distribution correctly prepared.
12. Time of file is identical on all pages of multi-page messages.
13. Proper use of correction tape. *NEAT CORRECTIONS.*
14. Proper typewriter and font used.
15. Addees requiring more than 1 line have second and subsequent lines indented five spaces.
16. DD-173 required for each part of sectional message.
17. No more than 69 characters to each line and 20 lines to each page.
18. Ensure compliance with instructions for use of DD-173 form.

EXERCISE (6-1-3)

1. Who has the responsibility of properly addressing, composing, and assigning precedence and format of a naval message?

(a) Typist **(c) Releasing authority**
(b) Drafter **(d) Communications**

2. When using a second page for a naval message, what information <u>must</u> appear on the DD-173?

____

____

____

JOINT MESSAGEFORM						SECURITY CLASSIFICATION CONFIDENTIAL				
PAGE	DTG RELEASER TIME			PRECEDENCE		CLASS	SPECAT	LMF	CIC	ORIG MSG IDENT
	DATE TIME	MONTH	YR	ACT	INFO					
01 OF 01				PP	PP	CCCC				1427104

BOOK — MESSAGE HANDLING INSTRUCTIONS: ZPW 152100Z APR 82

FROM USS CORAL SEA

TO AIG SEVEN SIX ZERO EIGHT

INFO NAVOCEANCOMDET CUBI PT RP

C O N F I D E N T I A L //N03144//

SYNOPTIC OBSERVATION (U)

(C) NAON 14184 99235 71548 42997 20712

10174 20140 40133 57007 70200 80002

22254 00152 20101 33411 40705

DECL 24 APR 82

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6 5 4 3 2 1 0

DISTR

DRAFTER TYPED NAME TITLE OFFICE SYMBOL PHONE	SPECIAL INSTRUCTIONS
AG3 I. R. SWIFT, METRO, 7103	MINIMIZE CONSIDERED
RELEASER — TYPED NAME TITLE OFFICE SYMBOL AND PHONE: F. VERGO, LCDR, METRO, 7105	
SIGNATURE	SECURITY CLASSIFICATION: CONFIDENTIAL; DATE TIME GROUP

DD FORM 1 MAR 79 173/2 (OCR) PREVIOUS EDITION IS OBSOLETE ☆ GPO: 1979 — 302-176

209.446

Figure 6-1-7.—Sample drafted message (Ship's synoptic observation).

PREPARING ACOUSTIC PRODUCT REQUESTS

With the ever increasing tactical application of oceanography, the Aerographer's Mate must supply a myriad of antisubmarine warfare (ASW) support. The complexed forecast can, to a certain degree, be made onboard ship and land stations—thanks to the new minit computer. However, most forecasts must be received from FLENUMOCEANCEN, Monterey, California. This massive computer house is designed to provide accurate forecasts in a minimum amount of time employing the latest in computer technology. To receive the ASW data quickly, a properly prepared message must be sent. Complete detailed information on services available from FLENUMOCEANCEN is available in *TACTICAL SUPPORT PRODUCTS MANUAL (U), VOL. I AND II, NAVOCEANCOMINST C3140.22.*

Services Available

There is a large variety of routine and tailored oceanographic and ASW data available to meet every need of a command. This data is classified and constantly updated to meet user needs, therefore, it cannot be discussed in this training manual. Aerographer's Mates requiring this information should refer to *NAVOCEANCOMINST C3140.22, VOL. I AND II.*

Typing and Preparing for Transmission

The APR will be typed using, in general, the same standard Naval Message Format already covered in this lesson. For further guidance on this subject refer to your supervisor.

EXERCISE (6-1-4)

1. **What publication(s) is/are used as a detailed reference for available oceanographic and ASW services available to shore and fleet units and commands?**

____

____

2. **What publication(s) is/are used to find precise procedures for preparing and drafting APRs?**

____

____

JOINT MESSAGEFORM

SECURITY CLASSIFICATION: UNCLASSIFIED

PAGE	DTG RELEASER TIME: DATE TIME	MONTH	YR	PRECEDENCE: ACT	INFO	CLASS	SPECAT	LMF	CIC	ORIG/MSG IDENT
01 OF 02				PP	PP	UUUU				3161236

BOOK | MESSAGE HANDLING INSTRUCTIONS

ZPW 130001Z NOV 82

FROM NAVEASTOCEANCEN NORFOLK VA

TO AIG ONE ONE SEVEN

AIG ONE THREE SEVEN

INFO FLENUMOCEANCEN MONTEREY CA

UNCLAS //N03145//

WWNT 1 KNGU 121200

AMENDMENT TO NAVEASTOCEANCEN NORFOLK VA CURRENT NORTH ATLANT

WIND WARNINGS (U)

1. CURRENT WIND WARNINGS FOR WINDS 35 KTS OR GREATER VALID FROM

121200Z TO 130000Z.

A. A 977MB GALE FORCE LOW CENTERED NEAR 60N09W IS MOVING NE AT 10 KTS

(1) WINDS OVER WATER 35 TO 45 KTS WITH GUSTS TO 55 KTS WITHIN AN AREA

BOUNDED BY 43N23W TO CST NR 43N09W CSTL TO 68N12.5E INCLUDING ENTIRE

NORTH AND BALTIC SEAS 68N10W 60N40W TO CST NR 50N56W CSTL TO 47N53W

TO ORIG PT 43N24W.

(2) AREA MOVING NE AT 10 KTS. WINDS WILL MAINTAIN GALE FORCE.

B. ELSEWHERE GALE WARNING:

(1) WINDS OVER WATER 30 TO 40 KTS CAUSED BY PINCHED GRADIENT BETWEEN

1009MB LO CENTERED NR 27N56W AND 1030MB HIGH CENTERED NEAR 38N63W

BOUNDED BY 32N65W 28N60W 36N40W 42N43W TO ORIG PT 38N65W.

DISTR

DRAFTER TYPED NAME TITLE OFFICE SYMBOL PHONE: AGAN I. C. BRINE, 741, 2242

SPECIAL INSTRUCTIONS

RELEASER — TYPED NAME TITLE OFFICE SYMBOL AND PHONE: E. I. EEOME, CDR, 744, 2241

SIGNATURE

SECURITY CLASSIFICATION: UNCLASSIFIED

DATE TIME GROUP

DD FORM 1 MAR 79 173/2 (OCR) PREVIOUS EDITION IS OBSOLETE GPO 1979 302-176

209.446

Figure 6-1-8.—Sample drafted message (High seas warning).

JOINT MESSAGEFORM

SECURITY CLASSIFICATION: UNCLASSIFIED

PAGE	DTG RELEASER TIME: DATE TIME	MONTH	YR	PRECEDENCE: ACT	INFO	CLASS	SPECAT	LMF	CIC	ORIG/MSG IDENT
02 OF 02				PP	PP	UUUU				3161236

BOOK | MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

2. IN ORDER TO SIMPLIFY DESCRIPTION, THE AREAS COVERED BY THIS WIND WARNING MAY ENCOMPASS SOME SMALL AREAS WHERE THE WIND WILL NOT BE AS STRONG AS INDICATED.

3. FOR AREA VICINITY BARENTS SEA, SEE NAVPOLAROCEANCEN SUITLAND, MD 121200Z.

4. INFORMATION USED IN PREPARATION OF THIS WARNING VT 120600OZ.

5. MY NEXT WIND WARNING WILL BE ISSUED AT 130000Z.

6
5
4
3
2
1
0

DISTR:

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE

SPECIAL INSTRUCTIONS

RELEASER: TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

SECURITY CLASSIFICATION: UNCLASSIFIED

DATE TIME GROUP

DD FORM MAR 79 173/2 (OCR) PREVIOUS EDITION IS OBSOLETE U GPO: 1979 — 302-176

209.446

Figure 6-1-8.—Sample drafted message (High seas warning)—Continued.

UNIT 6—LESSON 2

COMMUNICATIONS EQUIPMENT

OVERVIEW

Recognize the basic equipment used in the weather communication system.

OUTLINE

Teletypes

Radio Receivers

Facsimile

Weathervision

Communications System

COMMUNICATIONS EQUIPMENT

After weather observations have been taken and recorded on the appropriate forms, you must immediately disseminate the observation to all local operating units so that decisions concerning the weather's influence on their operations can be made. In addition, you must transmit the observation to both military and civilian weather stations throughout the world. This exchange of worldwide weather data supports military as well as civilian forecasting activities.

Learning Objective: Recognize the basic equipment used in the weather communication system.

This lesson discusses the basic communications equipment (teletype, facsimile, and the weathervision) used in transmitting and receiving weather data of all types.

NOTE: A complete detailed description and operational procedures of the equipment covered in this lesson can be found in the appropriate technical manual.

TELETYPES

The teletypewriter (teletype) is little more than an electrically operated typewriter. The prefix "tele" means "at a distance." By operating a keyboard similar to that of a typewriter, signals are produced that cause the teletype to print the selected characters (letters and figures). The signals can be sent by radio or landlines to cause the characters to be printed or displayed on other teletype machines.

Landline is a network of telephone companies' fixed wire circuits from station to station and from a control station to a group of stations.

Each circuit is engineered to meet specifications of individual users.

Radio is used where the use of landline circuits are either impracticable or impossible. Radio is the means by which various Naval Centrals, Naval Facilities, National Weather Service, and FAA activities transmit data to ships and overseas land stations, and vice versa. Data are transmitted by radio on predetermined frequencies and at predetermined time.

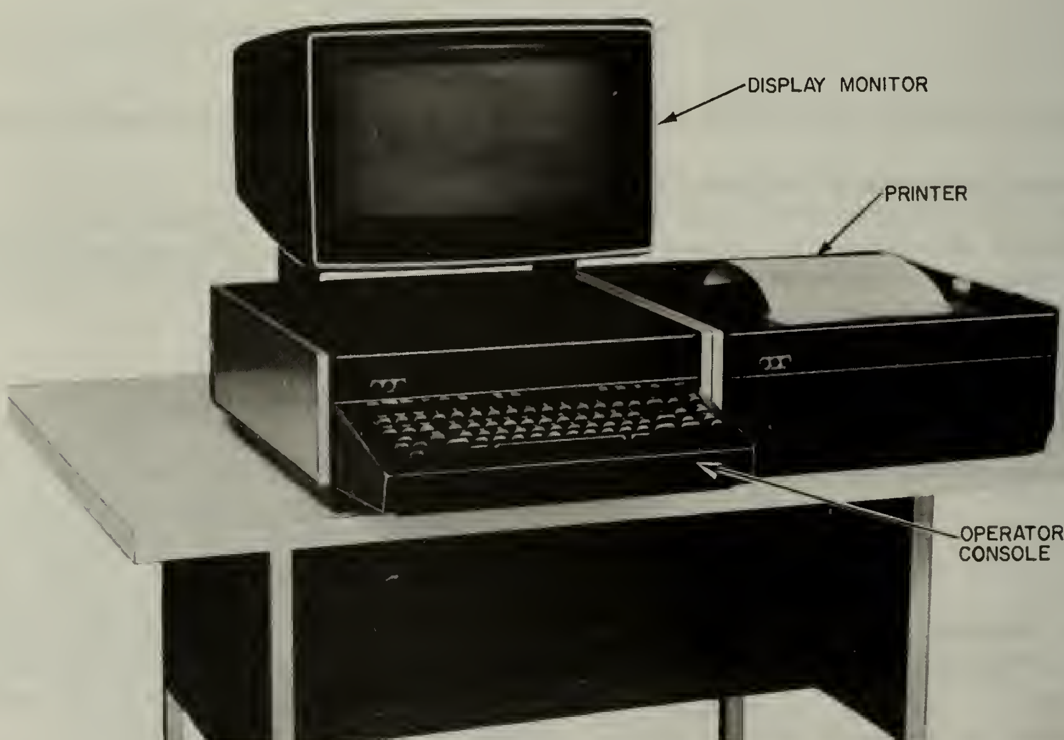
TELETYPE MODELS

There are two teletype models that you will most likely come in contact with at various shore stations. They are model 40 (COMEDS), used when the weather unit is a contributing station (figure 6-2-1), and the Model 28 RO (receive only) used for receiving data from various FAA and military circuits (figure 6-2-2).

Model 40 Teletype

The Model 40 teletype terminals provide you with advanced equipment for entering, storing, displaying, editing, printing, sending, and receiving weather data. Significant features of these terminals are: high speed, easy data preparation and editing, modular design, modern and versatile styling, quiet operation, and low maintenance. Eventually the Model 40 will be used as the standard teletype terminal replacing the Model 28 altogether.

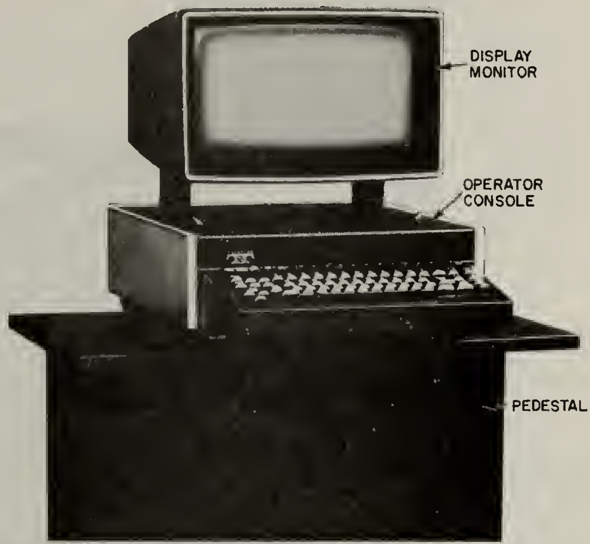
The discussion that follows does not provide you with every detailed operating feature and by no means is it intended to qualify you as a weather data communications expert. It is only through actual use and application of the principles that you come to completely understand the model 40 equipment and operation.



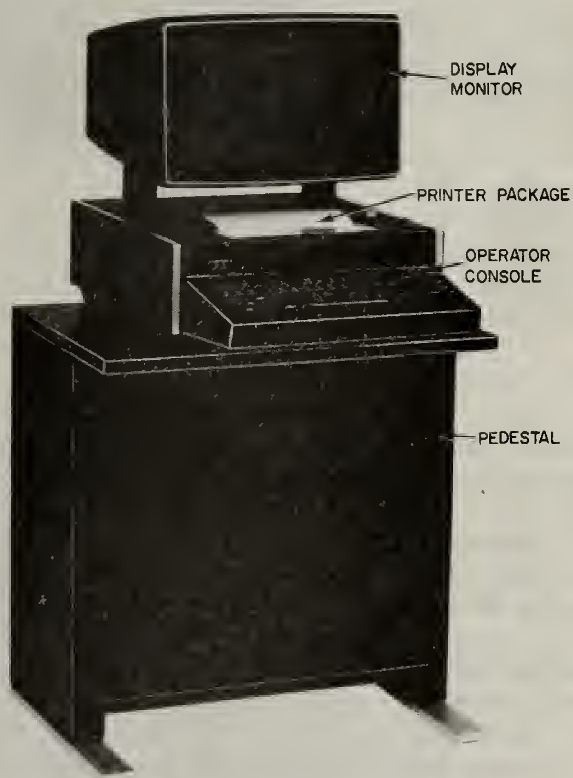
31.154

Figure 6-2-1.—Keyboard display printer (KDP) table mounted.

209.340
Figure 6-2-2.—Model 28 RO teletypewriter.



31.152
Figure 6-2-3.—Keyboard display (KD).

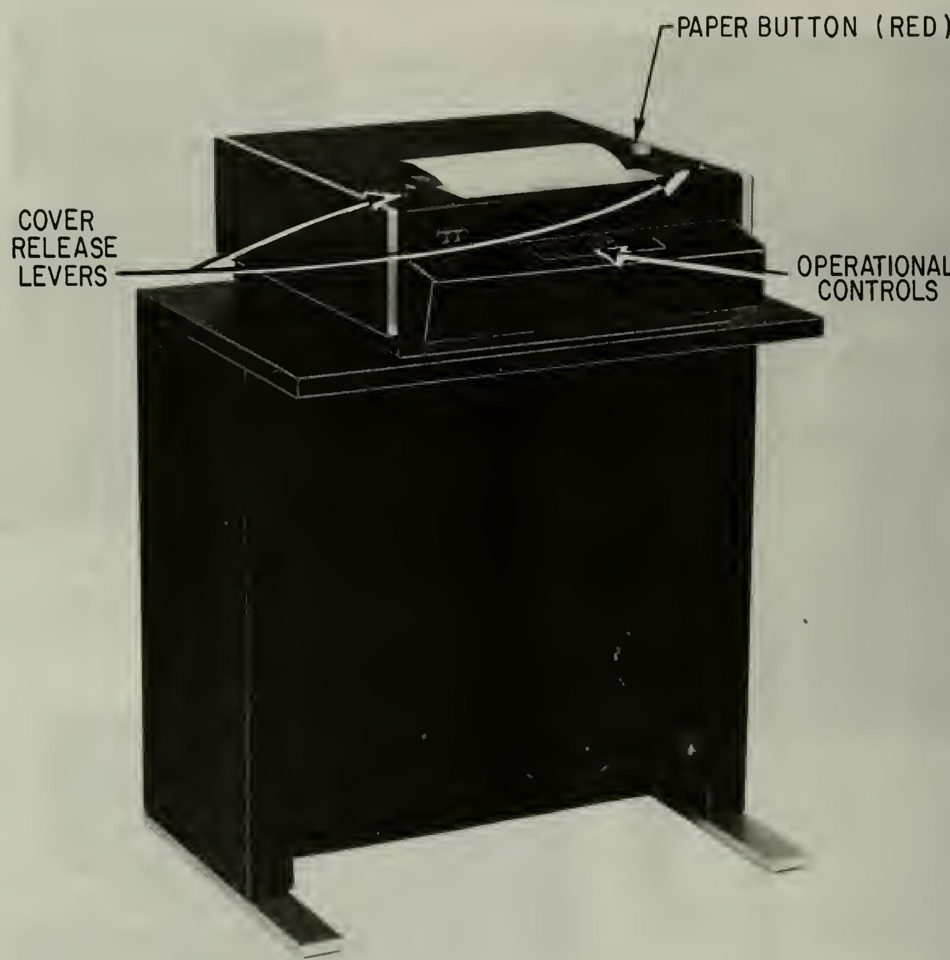


31.153
Figure 6-2-4.—Keyboard display printer (KDP) pedestal mounted.

THE MODEL 40 KEYBOARD DISPLAY (KD).—The model 40 (figure 6-2-3) displays weather data on a monitor that has a screen similar to a television set. When a weather message is typed locally on the keyboard, it is displayed on the screen. The low-glare glass on the screen makes the display easy to read. The message can be corrected locally by using the editing controls (discussed later) prior to transmission. Received weather data are also displayed.

THE MODEL 40 KEYBOARD DISPLAY PRINTER (KDP).—KDP is similar to a KD with the addition of a printer (figure 6-2-4).

THE MODEL 40 RECEIVE ONLY (RO).—RO receives weather messages on a hard copy



31.155

Figure 6-2-5.—Receiver only (RO).

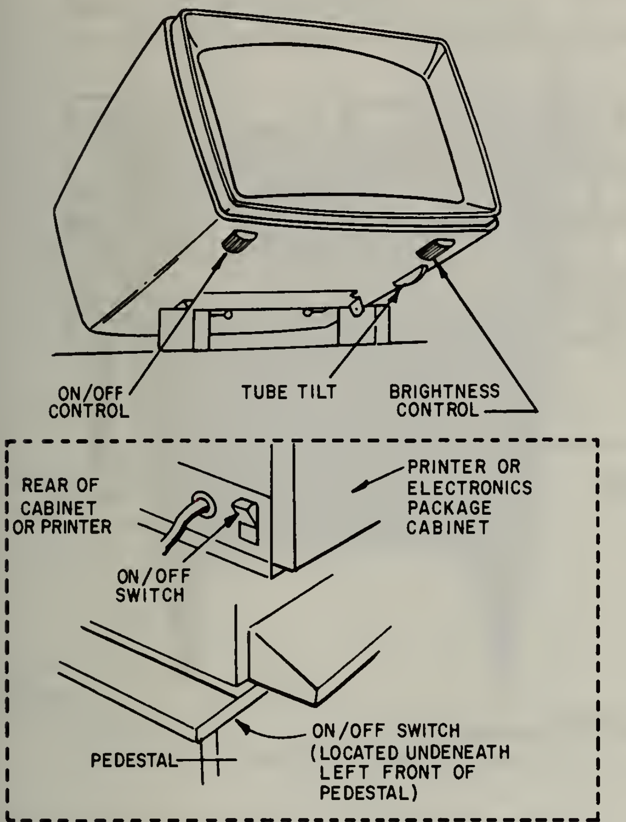
printer and provides you with a hard copy (teletype paper) of the received weather data (see figure 6-2-5).

The Model 40 terminal combinations may vary; however, the operations of each assembly within each terminal remains the same.

BASIC OPERATION (KD and KDP)

Power to the Model 40 KD and KDP is applied by switches located on the printer or electronic package cabinet, the pedestal, and the display monitor (shown in figure 6-2-6). Power to the display monitor may be turned off (KDP only) when the set is in receive or if PRINT ON LINE is selected to receive data. The keyboard is inoperative when the power to the display monitor is turned off.

The brightness control increases and decreases intensity of the displayed characters appearing on the monitor screen. Each character is formed on a 7 × 9 dot matrix (figure 6-2-7) and displayed on a flicker-free antiglare screen. The screen displays 24 lines of print at one time, with a maximum of 80 characters per line. The maximum capacity of the display system is 72 lines of print, divided into three pages of 24 lines each. The start of each page is identified by one or more dots appearing in the left-hand margin, opposite the start of the first line of each page. The first page is identified by one dot, the



31.156

Figure 6-2-6.—Model 40 power and control switch.

31.157

Figure 6-2-7.—Character formed on a 7 × 9 dot matrix.

second by two dots, and the third page by three dots in the left margin. The display line capacity is 80 characters; however, the Air Force Automated Digital Weather Switch (ADWS) at Carswell AFB, Texas, limits the maximum number of characters per line to 69. This allows the ADWS system to interface with other equipment which is limited to 69 characters per line, such as the FAA system.

Keyboard Assembly

The Model 40 keyboard (figure 6-2-8) is similar to that of an electric typewriter. It produces alphabetic characters in upper case only and certain other punctuation and character symbols. Since the Model 40 is used in applications other than the COMEDS network, some of its keys and functions have no use on the network. The symbols and punctuation appearing on the upper portion of certain keys may be obtained by pressing the SHIFT key and, while holding it, pressing the desired symbol key.

Note a number of two- and three-letter symbols above the letters of certain keys. These are control functions. The only one which you use is the end-of-text (ETX) function. It appears above the C key. This function is used at the end of your message to indicate to the computer that the transmission ends. You should enter it by holding down the CONTROL key (located beside the space bar) and depressing the C key. The ETX code appears on the display screen as an E_x. If you fail to place an ETX code at the end of your message, errors in transmission could result since the cursor would continue to transmit until it encounters another ETX code or reaches the last character of the last line of the third page of memory.

Within the keyboard proper, there are three keys which are never used: SYN, ACK, and NAK. These keys are used in other terminal applications for computer control, but have no application in COMEDS.

You end each line of your message with a NEW LINE function. This function creates a character, appearing as the symbol ≡ on the display screen that signals the Model 40 to transmit two carriage returns and one-line feed to the ADWS computer. Since you are limited to 69 characters per line in the COMEDS, this symbol should always appear at the end of each line of the message.

Teletype Model 28

There are various types of Model 28 teletypes, however, most of them have been replaced by

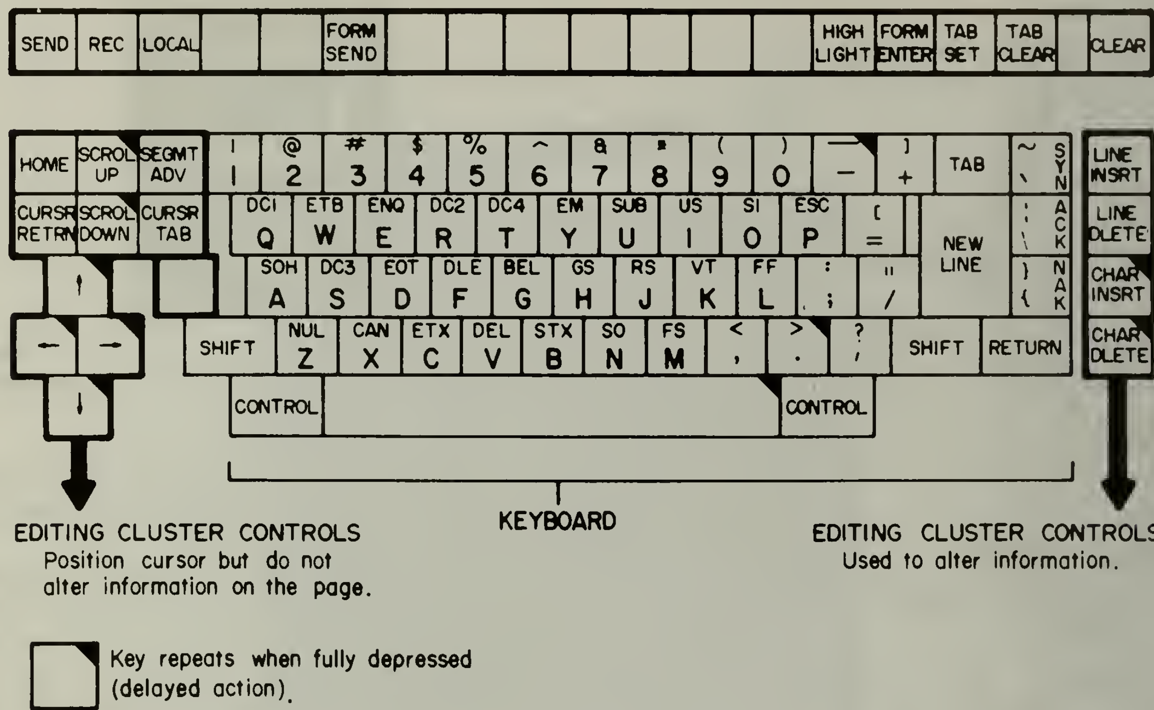


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Figure 6-2-8.—Model 40 keyboard.

the Model 40. Therefore, the Model 28 RO (receive only) is covered at this time.

MODEL 28 RO.—The Model 28 RO teletype (figure 6-2-9) is used for receiving weather data only. Normally, it does not have a keyboard. The only control keys provided on this machine besides the power switch are the carriage return (CR) key, which provides a means of locally returning the type box to the left-hand margin, and the line feed (LF) key, which provides a means of feeding the paper.

EXERCISE (6-2-1)

Complete the following statements by filling in the blanks.

1. **Some of the significant features of the Model 40 teletype terminals are: ____________, easy data preparation, and editing.**

2. **The Model 40 screen displays ____________ lines of print at one time, with a maximum of 80 characters per line.**

3. **Although the Model 40 screen can display 80 characters across on one line, ADWS limits the maximum number of characters per line to ____________.**

4. **The symbol ≡ on the display screen of the Model 40 denotes a ____________ function.**

209.340

Figure 6-2-9.—Model 28 RO teletypewriter.

RADIO RECEIVERS

Radio receivers are easy to operate and maintain. They are capable of receiving several types of signals and can be tuned accurately over a wide range of frequencies. Like everything else, radio receivers are improving each and every year.

One radio receiver that you are apt to see is the R-1051/URR. This receiver is used to copy teletype and facsimile frequencies for gathering teletype messages and weather maps.

RADIO RECEIVER R-1051/URR

Radio receiver R-1051/URR (figure 6-2-10) is designed to receive upper side band (USB), lower side band (LSB), independent side band (ISB), continuous wave (CW), tone modulated CW (MCW), compatible and standard amplitude modulated (AM), and frequency shift-keyed (FSK) transmissions in the 2- to 30-megacycle frequency range.

Comparator-Converter Group AN/URA-17C

The Comparator-Converter Group AN/URA-17C is used to convert the FSK audio

120.8

Figure 6-2-10.—Radio receiver R-1051B/URR.

output of standard radio receivers into dc pulses for the operation of teletype printers. The AN/URA-17C consists of two identical frequency shift converters, CV-483C/URA-17 (figure 6-2-11) and a closeup of one converter illustrating controls in figure 6-2-12. Each converter has its own comparator circuitry.

The comparator-converter can be operated with two radio receivers at the same time. The two receivers are tuned to different carrier frequencies that are carrying identical intelligence. Frequency diversity reception commonly is used aboard ship for copying fleet broadcasts keyed simultaneously on several frequencies.

In diversity reception, the audio output of each receiver is connected to its associated frequency shift converter. The converter converts the frequency shift characters into dc pulses. The dc (or mark-space) pulses from each converter are fed to the comparator. In the comparator, an automatic circuit compares the pulses and selects the stronger mark and the stronger space pulse for each character. The output of the comparator is connected to the teletypewriter.

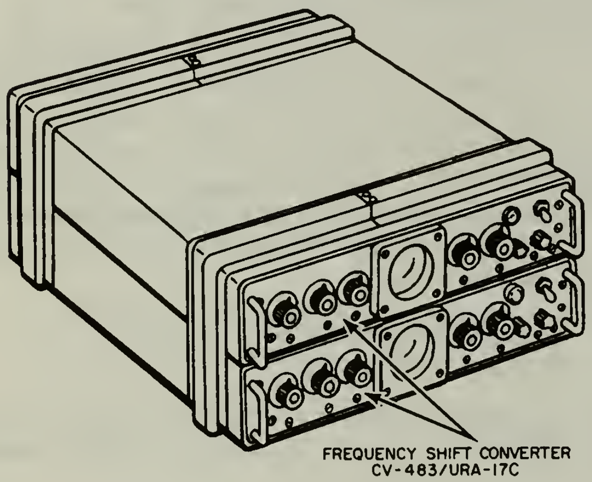

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Figure 6-2-11.—Comparator-converter group AN/URA-17(C).

FACSIMILE EQUIPMENT

Facsimile equipment is used to receive and record weather maps, satellite data, and other weather-type messages. (See figure 6-2-13.)

Facsimile transmission may be sent either by wire (landline) or by radio. In the United States the method of transmission is principally by wire. Aboard ship and overseas, stations receive facsimile weather charts by radio on certain designated frequencies of Navy broadcasts or by intercepting other transmitted frequencies

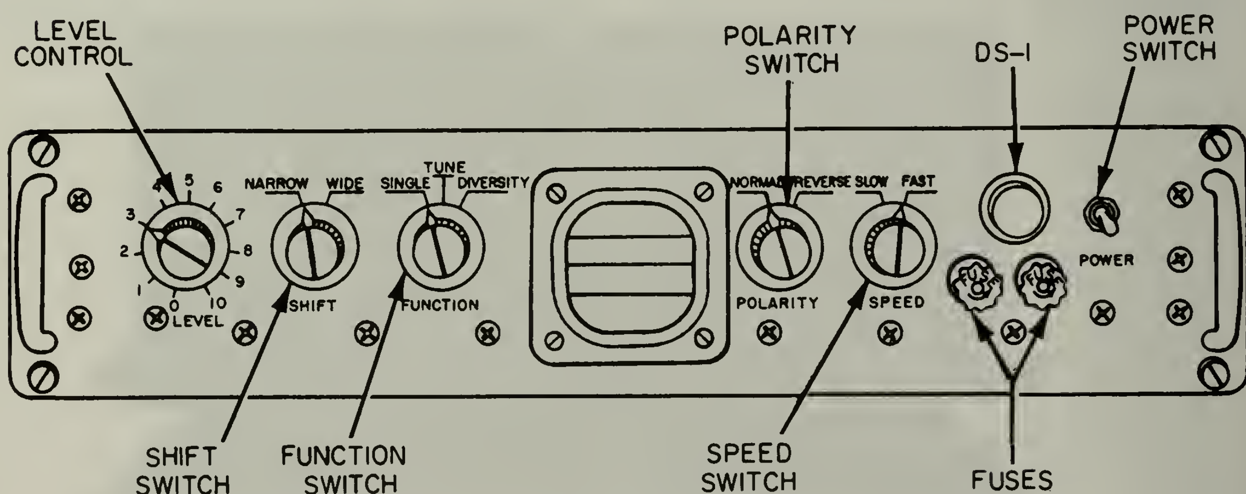

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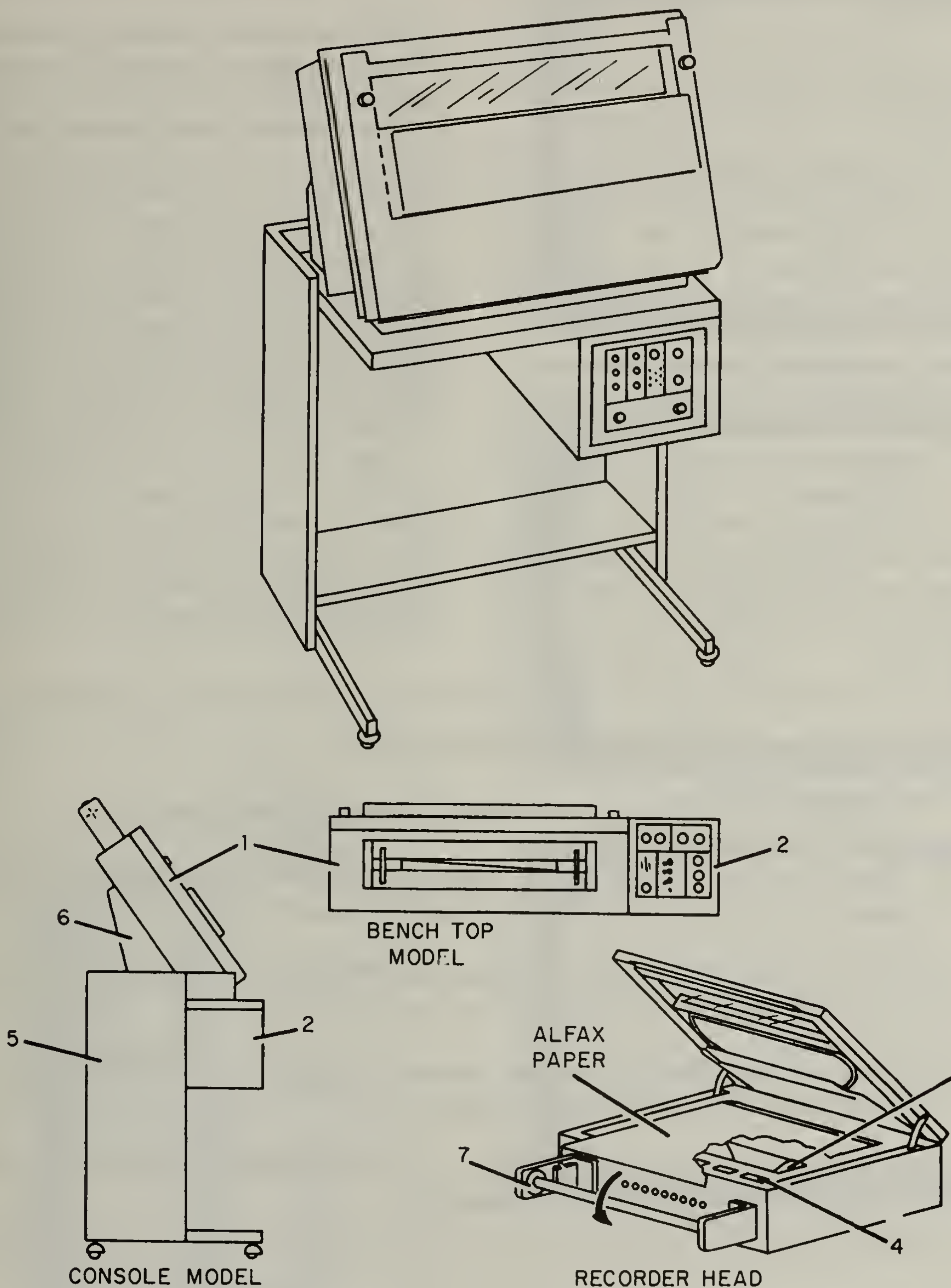
Figure 6-2-12.—AN/URA-17 frequency shift converter, front panel controls.



1. Recorder head.
2. Recorder control unit (electronic chassis).
3. Helix drum assembly.
4. Paper feed assembly.
5. Console (desk) assembly.
6. Stand assembly.
7. Paper take-up assembly.

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Figure 6-2-13.—Alden Facsimile recorder.

contained in the *Worldwide Marine Weather Broadcasts* manual.

ALDEN FACSIMILE (FAX)

All Alden facsimile equipments are about the same. They are fully automatic and can continuously receive weather maps. The recording process is done by the use of a FAX recorder and a ALFAX electrosensitive paper on which electricity is the ink. The paper used in the recorder gives a crisp sepia (brownish) map on a clean white background. The paper is thin and suitable for reproduction directly by the burning process. It is packaged in a sealed plastic bag and can be stored indefinitely without dating. With the front cover open, the roll of paper is easily snapped into place. After closing, the cover seals the paper in the recorder, preventing moisture loss.

WEATHERVISION SYSTEMS

Weathervision is nothing more than a closed circuit television system. The weathervision is used for transmitting weather information to several remote locations simultaneously.

AN/GMQ-27( ) WEATHERVISION

The AN/GMQ-27( ) weathervision (figure 6-2-14) consists of a television camera and console. This system is used to transmit weather maps and other meteorological information to receivers placed at various locations on the station as shown in figure 6-2-15. Weather briefings can also be given to pilots via a two-way radio system.

You should check the weathervision system daily for proper operation. Activate both the video and audio portions and check the reception at remote stations. If faulty operation is noted during the daily check, notify the proper maintenance personnel.

EXERCISE (6-2-2)

Complete the following statements by filling in the blanks.

1. **Radio receivers are capable of receiving several types of signals and be tuned ____________ over a wide range of frequencies.**
2. **The AN/URA-17C is used to convert the FSK audio output of a standard radio receiver into dc pulses for the operation of a ____________ printer.**
3. **Facsimile equipment is used to record weather ____________, satellite data, and other weather type messages.**
4. **Weathervision systems are used to transmit weather information to ____________ locations simultaneously.**

COMMUNICATION SYSTEMS

Weather data observed or received during your shift on duty are needed for the planning of naval operations. Weather not only affects flight operations but also has direct bearing on most military operations. Your weather observations need to be immediately disseminated to all local operating units so they can make decisions concerning the weather's influence on their operations. In addition, your observations are relayed to all other locations that need the information for their operations.

Both military and civilian weather observations are sent throughout the world. They may be transmitted by teletype, radioteletype, and continuous wave (CW) radio broadcast. This exchange of worldwide weather data

supports civilian as well as military forecasting activities.

This lesson discusses the various methods used to transmit and receive weather data of all types. If your assignment is at a detachment, your primary concern is to disseminate weather data to the operating agencies. Your next concern is to transmit the weather data to the Automated Weather Network (AWN). You need to study the responsibilities of the Air Force Communications Service (AFCS), the Air Weather Service (AWS), and the Modernized Weather Teletypewriter Communications System (MWTCS) in the exchange of weather data. This lesson also discusses the CONUS Meteorological Data System (COMEDS).

WEATHER COMMUNICATION SYSTEM

Long-line dissemination of weather data between military weather stations is done by

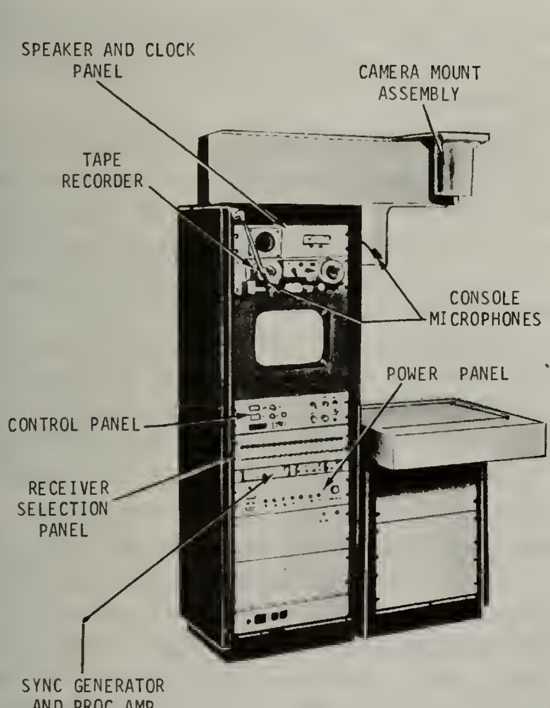

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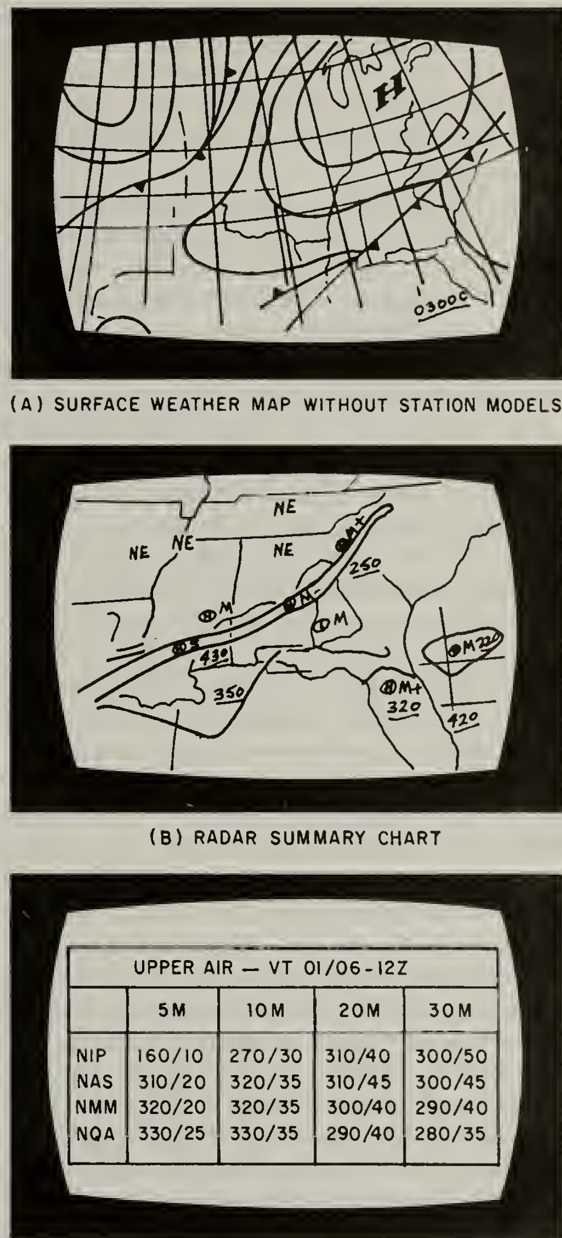
Figure 6-2-14.—Weather vision—System AN/GMQ-27( ).



(A) SURFACE WEATHER MAP WITHOUT STATION MODELS

(B) RADAR SUMMARY CHART

(C) UPPER AIR FORECAST DATA

209.438
Figure 6-2-15.—Typical weather vision transmissions.

an automatic collection-dissemination network operated by weather editors and AFCS personnel. At most weather office assignments, your duties include handling and transmitting weather data. These tasks contribute to the global interchange of weather data and are essential to the

operational effectiveness of your unit. As an observer, you are a key man in this interchange of weather data. To fully understand your role in the dissemination of weather data, you must know about the various weather networks and their operation.

The USAF/DCS weather communications networks are the weather teletype networks, including the Automated Weather Network (AWN), the weather facsimile networks, and the global weather intercept and broadcast networks. They provide the facilities for rapid interchange of weather data on a worldwide basis.

The mission of the USAF/DCS weather communications network is to provide communications service to the Department of Defense (DOD) agencies and the Air Weather Service in support of global missions. Weather data, because of its unique character and because of the volumes of information that must have wide and timely dissemination, requires special communications network and message handling procedures. The USAF/DCS weather communications networks and the AWN provide this unique service.

To make this service operate smoothly, all observer personnel who operate weather communications facilities must follow the policies and procedures contained in AWSR 105-2, *Weather Communications*. Operating schedules, detailed instructions, and supplementary procedures are issued by the responsible AFCS echelon to expand on AWSP 105-52, Volume 3, *Weather Communications* (Weather Message Catalog), for teletype; use Volume 1, *Facsimile Products Catalog*, for facsimile. AWSP 105-52, Volume 2, is a Weather Station Index which provides a master index of weather stations throughout the world. These two volumes contain complete descriptions of all weather message products available within the USAF weather communications system. They govern the military contribution to the overall interchange of weather data.

The interchange of weather data between various countries is done through sophisticated communications systems. These highly computerized systems are able to handle large volumes of data within a very short time. In addition, centralized data relay sites have reduced costs while improving the data available. Much of the military and civilian weather dissemination systems have been absorbed into this unified system, called the Automated Weather Network.

Air Weather Service Teletype System

In 1976, the three-circuit COMET (CONUS Meteorological Teletype System) network was replaced by a single, medium speed, versatile communication system. The new system (shown in figure 6-2-16), CONUS Meteorological Data System (COMEDS), is a simplified design that operates to save costs by reducing message preparation time and paper consumption. In addition, the cost of two circuits and their associated equipment has been eliminated. COMEDS is a computerized weather and notice to airmen (NOTAM) system serving essentially the same purpose as the COMET system. As in COMET systems, you can make an automatic request and query (ARQ) for data such as rawinsonde and international weather data.

You can prepare messages without using paper tape. If you make a mistake, it is easily corrected by entering corrected data over the faulty data.

Another feature of the new COMEDS is the ability to receive messages on a display rather than on a printer. This cuts down on the amount of paper you must tear and file. Also, the ARQ data by other stations on your circuit are not printed on your terminal—again saving time and paper. Since each terminal can be either selected or not selected, you can get ARQ data for the few stations in which you are interested rather than printing a whole sequence just to obtain data for one or two synoptic or rawinsonde stations.

Military weather communications is a large part of your workload while you are on duty in a base weather station. You are continually filing and posting the incoming weather messages in their correct positions. The longer you are associated with weather communications, the better versed in its procedures you become. As you progress through the various levels of the weather career ladder, you should also know about the civilian weather communications system so that you can use its forecast and observation resources.

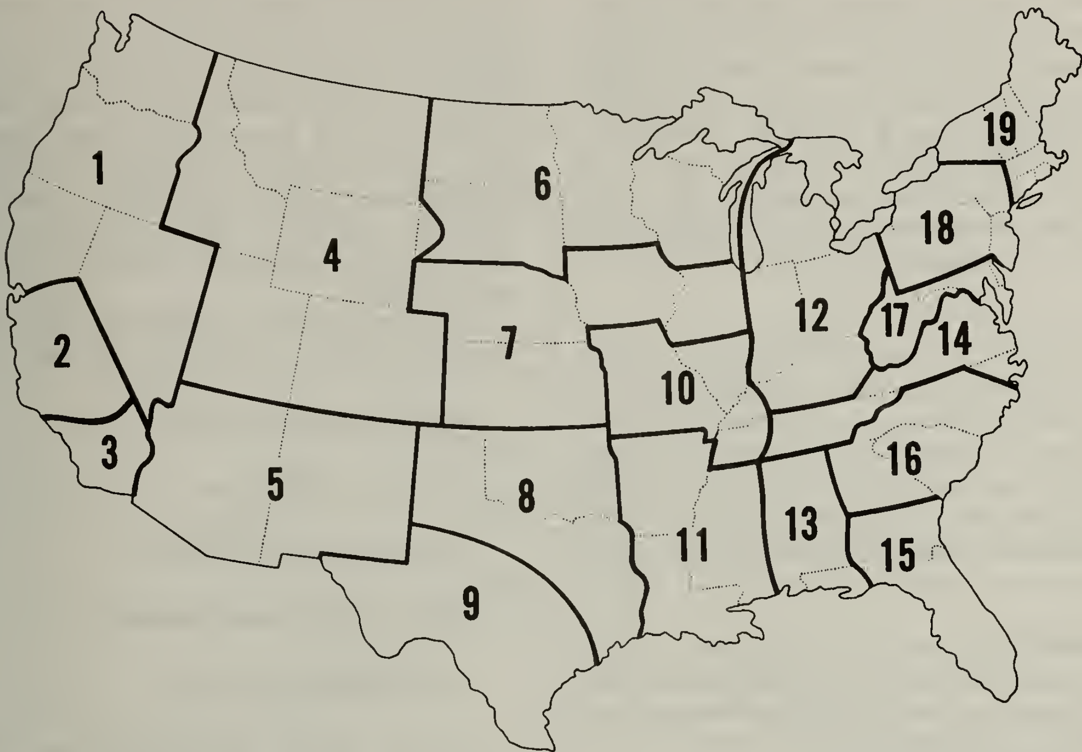


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Figure 6-2-16.—COMEDS circuit areas.

National Weather Service (NWS) Teletype Systems

The Federal Aviation Administration (FAA) controls the National Weather Service Communications System. The major difference between the COMEDS used by the military and the civilian weather circuits used in the field is speed.

This central relay point, called the Weather Message Switching Center (WMSC), is located in Kansas City, Missouri. This center is the computerized circuit control point of the Modernized Weather Teletype Communications System (MWTCS). The MWTCS is the relay point for these FAA Services: A (aviation), C (synoptic), and O (overseas). The military dedicated Service A network also originates here. The civilian aviation weather data you receive is also routed through these computers. Only certain sections of the Service O (overseas) circuits go through this complex. The other sections go through the ADWS at Carswell AFB, Texas. Another separate FAA circuit, the ARQ circuit, also goes through the MWTCS computer. If the ARQ data is not available at the MWSC complex, it is requested from the ADWS computers at Carswell AFB.

Each of the NWS teletype circuits is governed by an FAA publication. These publications describe each message type (by heading) and the proper format for transmitting it on the circuit. In this respect, the publication is similar to AWSR 105-2 and AWSP 105-52, Vol. III.

SERVICE A.—Service A consists of weather circuits which provide aviation weather and notice to airmen (NOTAM) messages to civilian and military sites throughout the United States. Certain other message types, such as pilot reports (PIREPS) and radar reports (RAREPS) are also transmitted on this circuit. The weather data is collected each hour, on the hour; it is routed to other circuits after being arranged into

bulletins by the computers. Each distribution point "hub" within the system collects its data and transmits this data both to other stations in the hub and to MWTCS. Stations outside the hub have their data transmitted to the hub stations after the primary data is collected. The amount of outside data relayed is limited because of circuit time limitations and because of paper consumption considerations. Station data requirements are coordinated with the MWTCS center yearly.

SERVICE C.—Service C is another NWS teletype network which handles synoptic (3- and 6-hour) data and upper air information. It also provides state weather forecasts and comments concerning weather products produced at the National Weather Center located at Silver Spring, Maryland. Severe weather and public information bulletins are also sent on this circuit.

SERVICE O.—Service O provides aviation weather data and forecasts between international sites. It is used by the FAA to interchange data with Mexico, the Virgin Islands, Bermuda, and other overseas locations.

AUTOMATED WEATHER NETWORK (AWN).—Although most weather personnel understand the basic operations of the Automated Weather Network, few weather specialists realize the significance of their duties in relation to the AWN operation. Each weather message you transmit is processed into the AWN for further dissemination. The quality of these transmissions determines the success of the AWN operation; therefore, you must know local communications policies and understand the operation of the AWN.

The Automated Weather Network consists of real-time computers located in major population centers of the world. Weather data is collected by low-speed communications systems within each area and then relayed at high speed between centers. Figure 6-2-17 shows the major free-world relay centers which exchange military and civilian weather information throughout the world. Some civilian weather data is collected within the Asian Continent and relayed through Moscow directly to National Weather Service computers at Silver Spring, Maryland. There, it is combined with Canadian weather reports and sent to the AWN site at Carswell AFB, Texas. Some data (which may have doubtful validity) is transmitted, with appropriate indicators, from radio intercept sites overseas to Carswell AFB for evaluation. The more routine data received at the Carswell Automatic Digital Weather Switch (ADWS) is checked for proper format automatically and then routed to customers within the western hemisphere in accordance with their requirements.

Currently, there are four free-world ADWSs which service six high-speed data users:

- Carswell AFB Texas
- Fuchu AB, Japan
- Clark AB, Philippines
- Croughton AS, England

The high-speed users are:

- Air Force Global Weather Central (AFGWC), Offutt AFB, Nebraska
- Air Force Asia Weather Central (AWC), Fuchu AS, Japan
- Air Force European Weather Central (EWC), Croughton AS, England
- National Meteorological Center (NMC), National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA), Silver Spring, Maryland.
- Weather Message Switching Center (WMSC), Federal Aviation Administration (FAA), Kansas City, Missouri.
- Fleet Numerical Oceanography Center (FNOC), US Navy, Monterey, California.

Notice in figure 6-2-17 that the hub of AWN is the Automatic Digital Weather Switch (ADWS) at Carswell AFB, Texas. With the changeover from the COMET system to COMEDS, the relay point at Tinker AFB, Oklahoma, has been eliminated; the COMEDS terminals are linked

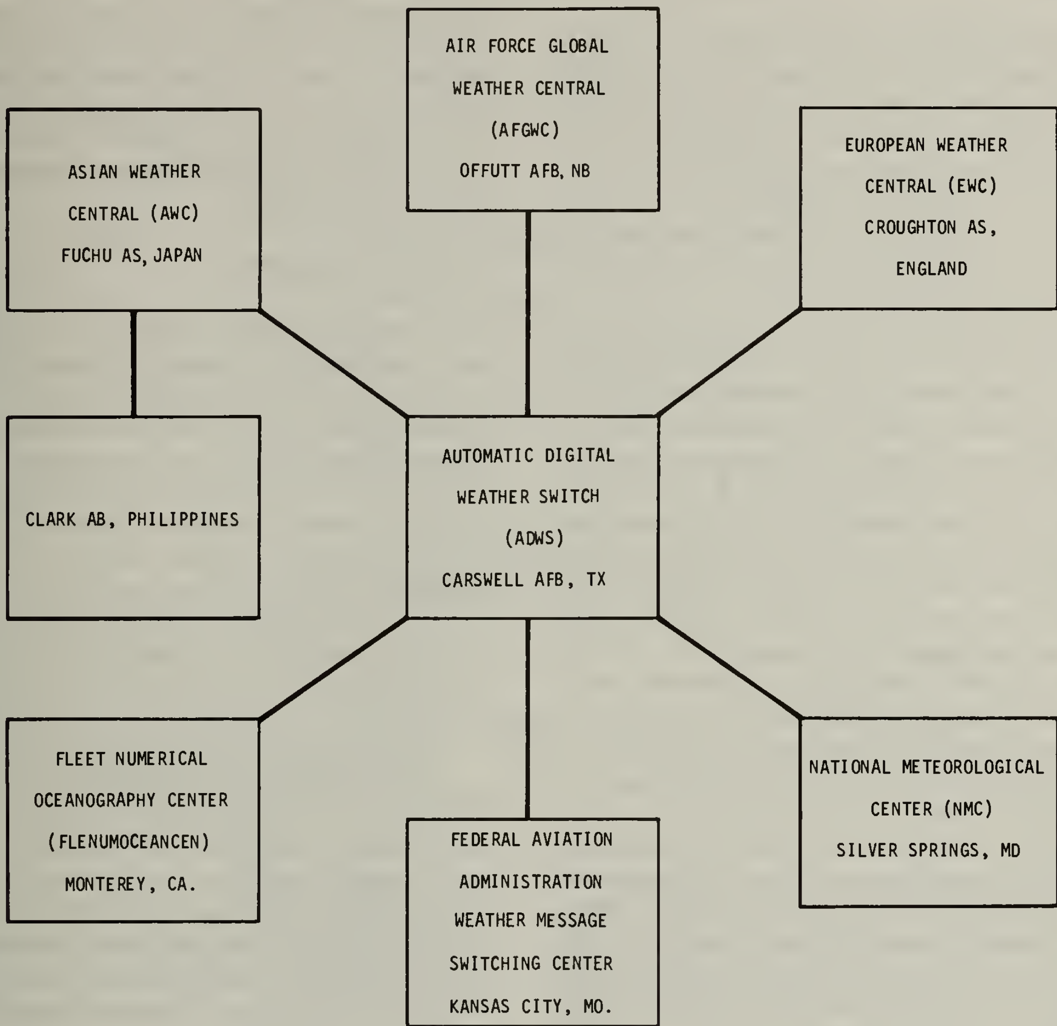

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Figure 6-2-17.—Automated weather network.

directly with the ADWS computers at Carswell AFB. The data links between the various parts of the AWN system are two-way; they operate at speeds as high as 4800 words per minute. The AWN system is gradually being upgraded. In time it will automatically control virtually all of the weather collection and relay functions within the United States.

Astro/Geophysical Teletype Network (ATN)

The ATN is a solar observing and forecasting network originating from the Automatic Digital Weather Switch at Carswell AFB, Texas. It handles the AWS Space Environment Support System (SESS). The SESS is a worldwide network of solar optical, radio, and ionospheric observing and forecasting sites located at both civilian and military installations. It exists for the purpose of collecting routine and special (near real-time) astro/geophysical data and for relaying forecasts to and from the Aerospace Environmental Support Center (AESC), NORAD, Cheyenne Mountain Complex, Colorado. The data and forecasts are used to make decisions affecting various military communications systems.

Intercepts

Countries with isolated areas or primitive communications systems send most of their weather data by radio. The Air Force and Navy operate intercept radio receiving sites to obtain this weather data. By the use of these sites, not only are more reports available, but the data received is more timely. Delays that occur in relaying the data through civilian channels can be as much as 6 hours.

Some reporting stations may not be listed in the directory published by the World Meteorological Organization. If the intercept sites receive such data along with data from known sites in the same message group, the unknown station's location can be estimated. As more data is received and compared, the site's location can be more closely established. Once the site is located with sufficient accuracy, the data it transmits can be used to fill in details within lesser sampled areas of the world. This locator function is performed at the weather editor section of Carswell ADWS.

Six Air Force and one Navy site handle most of the intercept work. Each site is assigned an area of responsibility. In addition, each site is equipped to act as a backup receiving site for the others. The general area each site monitors is shown in table 6-2-1 and in AWSM 100-1, *Global Weather Intercepts*. Also listed in the table is the nearest center through which the weather message is relayed to the Automated Weather Network (AWN). For example, Torrejon, Spain, passes its weather intercepts through the relay center at Croughton, England. The Ie Shima, Okinawa, intercepts pass through the relay center at Fuchu, Japan.

FACSIMILE COMMUNICATIONS SYSTEM

The USAF/DCS Weather Facsimile Communications Global System is comprised of networks which serve all DOD requirements and interface with the National Weather Service (NWS) and Federal Aviation Administration (FAA) networks. Facsimile products, by their uniqueness in composition, handling procedures, and acquisition of data, require special communications networks. Recent changes in machine capabilities within the DOD facsimile networks have required that the communications lines be improved to provide the detail needed in some maps. However, the basic objective of the system remains the same. That objective is to transfer information of a graphic nature quickly, accurately, and reliably from central preparation points to field sites.

System Composition

The weather facsimile networks are primarily composed of the Strategic Facsimile Network and the National Facsimile Network within the CONUS and the European and Pacific Facsimile Networks overseas. With the exception of a few radio links, these networks operate at either 120 or 240 scans per minute (SPM). Within the CONUS, four facsimile networks carry the majority of the weather graphics. These are: WFX 1234, FOFAX, AFX109, and NAMFAX. Of these circuits, three (FOFAX, AFX109, and NAMFAX) use the DL-MDC converter or its equivalent.

NATIONAL FACSIMILE NETWORK (WFX 1234).—The National Facsimile Network is the basic weather graphics network. It transmits graphics such as surface analysis charts, computer-plotted upper air charts (850, 700, 500, 300, and 200 mb), weather depiction charts, and prognostic maps. It is primarily oriented toward low-altitude aviation interests and surface weather forecasting.

Most of the material transmitted originates at the National Meteorological Center (NMC), Silver Spring, Maryland. The network extends throughout the United States with communications links to Canada at Vancouver and Montreal. Selected charts are also relayed to Hawaii and Puerto Rico. All maps on this circuit are transmitted at 120 scans per minute.

FORECAST OFFICE FACSIMILE SYSTEM (FOFAX, GS 10206, 7, 8).—This network is often referred to as the satellite network. FOFAX serves civilian forecast offices and military weather stations by providing satellite material and other meteorological graphics needed in their preparation of forecasts and weather warnings. In addition to the satellite data, this network

Table 6-2-1.—Intercept Stations and Monitor Areas

Intercept Station	Monitored Area	Relayed to AWN Through
RAF Croughton, England	USSR	Croughton, England
Torrejon AB, Spain	Western and Southern Africa	Croughton, England
Incirlik AB, Turkey	Middle East, Eastern Africa, Southern USSR, India (New Dehli)	Croughton, England
Fuchu AS, Japan	People's Republic of China, North Korea	Fuchu, Japan
Ie Shima, Okinawa	People's Republic of China, Pakistan, New Zealand, India (New Dehli), South East Asia	Fuchu, Japan
Clark AB, Philippines	South East Asia	Clark AB, Philippines
San Miguel US Navy Communications Facility, Philippines	Australia, Indonesia, Pakistan, New Zealand, India	Clark AB, Philippines

transmits three hourly pressure-change and height-change charts, preliminary analysis and forecasts charts, and delayed NMC prognosis charts. Charts are transmitted at both 120 and 240 scans per minute on this circuit.

The network also distributes National Environmental Satellite Service digitally prepared satellite mosaics from both polar-orbiting and geostationary satellites. The three sites normally used to receive these satellite signals are Wallops Island, Virginia; WBFO San Francisco, California; and AF Kunia, Hawaii. The San Francisco unit has the ability to transmit recorded satellite data on the FOFAX network upon request by other offices.

STRATEGIC FACSIMILE NETWORK (AFX109).—This is a military network, terminating at various locations, which primarily transmits graphics used for high-performance aircraft. Certain data extends as high as 30 mb. Data transmitted includes gridded forecasts and analysis, Northern Hemisphere significant weather/1000-mb D-value progs, contrail forecasts, tropical streamline charts, and weather warning charts. These products may be transmitted at either 120 or 240 scans per minute.

NATIONAL AND AVIATION METEOROLOGICAL FACSIMILE NETWORK (NAMFAX).—This network distributes analyses, prognoses, and selected observational data to offices supporting international high-altitude civilian aviation operations. NAMFAX replaces NAFAX and the old Aviation Meteorological Facsimile (AMFAX) Network at those locations which previously had the AMFAX circuit. The newer network carries area forecasts of winds, temperatures, and significant weather primarily intended for international flights above 20,000 feet.

Graphic guidance materials in the form of manually prepared prognoses are entered

by Montreal, Canada, and the National Meteorological Center, Silver Spring, Maryland. Additional entries to the circuit are numerically prepared prognostic charts from NMC and digitized cloud mosaics from NESS. The network is linked to the NWS Alaska network and Puerto Rico, as well as Canada and Mexico. Data on this network is transmitted at both 120 and 240 scans per minute.

EXERCISE (6-2-3)

Complete the following statements by filling in the blank.

1. **To make the AWN communications system operate smoothly, you must follow the procedures and schedules contained in AWSR 105-2, Weather Communications, and the AWSP 105-52, Volume____________.**

2. **The FAA central relay point is called the Weather Message Switching Center (WMSC) and is located at____________.**

3. **A NWS circuit that provides aviation weather and notice to airman (NOTAM) messages to military and civilian is known as service ____________.**

4. **A NWS circuit that handles synoptic (3- and 6-hour) data and upper air data is known as service____________.**

5. **An NWS circuit that provides aviation weather data and forecasts between international sites is known as service____________.**

6. **FOFAX facsimile network is referred to as the____________network.**

7. **NAMFAX facsimile network distributes analysis, prognoses, and selected observational data to offices supporting international high-altitude civilian____________operations.**

UNIT 6—LESSON 3

NAVAL ENVIRONMENTAL DISPLAY STATION (NEDS)

OVERVIEW

Recognize the procedures for operating the Naval Environmental Display Station.

OUTLINE

Purpose and content
NEDS terminal components
Advantages

NAVAL ENVIRONMENTAL DISPLAY STATION (NEDS)

Learning Objective: Identify the component parts of the NEDS and show familiarity with the capabilities of the NEDS system and its operation.

PURPOSE AND CONTENT

The NEDS is a display terminal that employs a mini computer with storage capability, a television monitor display, and a high-speed hard copy plotter/printer to create, store and transmit environmental data. NEDS replaces previous automatic data processing equipment at Naval Oceanography Command activities and will be the major environmental and communications equipment at all shore activities in the future. Currently, two models are in service with the fleet. NEDS-1 and NEDS-1A. NEDS-1 units operate at a higher transmission note and are to be located at the centers and other major locations (such as the Pentagon). NEDS-1As are designed to serve at the other NAVOCEANCOM activities worldwide. A more rugged NEDS model is being developed for shipboard use.

NEDS is able to encrypt environmental information when interfaced with crypto equipment for secure data transmission.

NEDS TERMINAL COMPONENTS

CONTROL INDICATOR GROUP

The Control Indicator Group (CIG) has all the controls to operate the entire NEDS system and it has three major units:

- The CRT (TV) screen (graphic): On this screen, charts are displayed in varying colors and formats. The operator controls the graphic screen through a calculator-style keyboard. With the keyboard, the operator can choose the various charts for display. A chart can be enlarged (zoom), notated and overlayed on each other using keyboard controls.

- CRT (TV) Screen (Alphanumeric): This screen displays messages such as weather warnings and signets. It is also used like a word processor to display typed messages by the operator. It is controlled by a typewriter-style keyboard. A listing of all commands and control inputs can be displayed on this screen. The keyboard can also be used to produce graphics on the graphic screen.

- Graphic Pen Interface: This pen is used to alter the charts displayed on the graphic CRT. It enables the operator to reanalyze displayed charts and add information (e.g., weather symbols) to the charts.

A telephone is installed on the NEDS-1 which enables the operator to communicate with other terminals.

DATA PROCESSING GROUP

The Data Processing Group (DPG) receives both digital and alphanumerical (A/N) information. This information can be received/sent at very high speeds, (up to 2400 bits per second) via standard landlines. The information is then processed and transferred to the mini computer where they may be displayed on the TV screen immediately or placed in the mini computer's memory bank (on disk) for later use. Currently it takes about 10 minutes on NEDS-1A to receive the data, process it, and create a weather map, but this time decreases as the rate of data transmission increases. The NEDS-1, using higher speed communications, is able to produce a chart every 15 seconds. The data processor also serves as a word processor and enables the operator to type messages into the NEDS for display on the TV monitor. It sends the completed weather message on to the fleet. The entire operation of the DPG is controlled through the keyboard located in the CIG.

ELECTROSTATIC PRINTER/PLOTTER

The Electrostatic Printer/Plotter is a separate unit in the NEDS-1 Model and is built into the CIG on the NEDS-1A units. The printer/plotter operates at extremely high speeds and is capable of printing a map out every 10 to 15 seconds. The printer/plotter is controlled by the keyboard on the control unit and weather messages (teletype format and standard naval messages off of the Autodin Network) can be printed out equally fast. The printer/plotter uses a special type of paper that is sensitive to minute electrical impulses. This eliminates the need for pen and ink which is a significant improvement over older equipment.

Fleet Numerical Oceanography Center, Monterey, California, is the central control for the NEDS network, and the data flows via the Naval Environmental Data Network (NEDN) and the Automated Weather Network (AWN).

ADVANTAGES

The NEDS system contains several significant advantages over all previous environmental data terminals.

- It can receive A/N (alphanumerical) and analog data at very high speeds, reducing delivery time for vital environmental data.

- It can store data for later use on the disk and enables the operator to display the transmitted data on a TV screen, print it out in hard copy format, and/or store it for later use.

- It allows operators to alter maps that are displayed on the TV monitor. Through the use of a "light pen," aircraft flight paths, weather warning areas and various other graphic additions can be made to the displayed maps. Map background can also be altered to construct a map over the precise area of interest at a varying scale—e.g., the terminal can expand (zoom in) a particular area of interest; also several charts can be overlayed at a time giving a three-dimensional picture to the forecaster.

- The NEDS can display and print weather maps, teletype data and message data from the AWN network, decreasing the AG's dependence on different teletype circuits and communication centers. NEDS acts as a word processor, allowing the operator to format outgoing messages and immediately transmit the information to the user (encrypted if necessary).

- By eliminating older pen and ink plotting methods through the use of electric sensitive data, printing/plotting is achieved.

The NEDS terminal equipment is still undergoing development, and additional changes will occur. Refer to the various operating manuals to keep up-to-date on any additional changes in operating instructions. It is expected that the NEDS acronym may be changed to FMC-1/FMC-2/FMC-3 and FMC-4 in the near future as development continues.

EXERCISE (6-3-1)

Complete statements 1 through 3.

1. **The CRT (TV) screen (graphic) can display charts in varying ________________________ and formats.**

2. **The CRT (TV) screen (Alphanumeric) can display messages such as weather, ________________________, and signets.**

3. **The printer/plotter operates at extremely high speeds and is capable of printing a map out every ______________ seconds.**

APPENDIX 1

EXERCISE ANSWERS

FOREWORD

The exercises in each lesson complement the subject matter and give you the opportunity to check your progress. You will not be graded on the exercises. Only you will know if you have answered the exercises correctly.

If you do not agree with the answer to any part of an exercise item, or if you cannot arrive at the answer given, consult your supervisor.

The following examples will explain how appendix I is arranged.

(1-2-3) Indicates the (1) unit number; (2) lesson number; and (3) exercise number, with the answers to the exercises to follow.

APPENDIX I

EXERCISE ANSWERS

UNIT 1

LESSON 1

(1-1-1)	(1) L2	(4) L3	(7) L6
	(2) L8	(5) L4	(8) L9
	(3) L1	(6) L5	(9) L7
(1-1-2)	(1) M1	(4) M3	(7) M4
	(2) M6	(5) M7	(8) M5
	(3) M2	(6) M9	(9) M8
(1-1-3)	(1) H9	(4) H1	(7) H4
	(2) H3	(5) H5	(8) H6
	(3) H7	(6) H2	(9) H8
(1-1-4)	(1) Lenticular, M4	(2) Foehnwall, L5	(3) Rotor, L2
(1-1-5)	(1) 1468	(3) 1930	(5) 1500
	(2) 1070	(4) 15//	(6) 1501

(1-1-6)
1. 9 SCT 120 BKN 230 BKN
2. 12 SCT 160-BKN 250 OVC
3. -X 16 BKN 150 OVC

(1-1-7)
1. A ceiling is the height ascribed to the lowest broken or overcast layer aloft not classified as thin, or the vertical visibility in a surface-based obscuring phenomenon.
2. (1) Rotating beam ceilometer.

   (2) Ceiling light.

   (3) Known heights of unobscured portions of isolated objects within 1 1/2 miles of the runway.

(1-1-7) Cont.

3. Use the RBC for an alternate runway, if you consider it to be representative.

4. Supplement scope height indications with visual observations.

5. Use available scope reactions and average the readings.

(1-1-8) **Statements 1, 3, 4, 6, 8, 9, and 10 are false.**

1. The height above the MSL, reported by a pilot, must be converted to the height above ground level.

3. The appropriate colored balloon for estimating the height of a thin cloud layer is red.

4. The convective cloud height diagram is not suitable for use in mountainous or hilly terrain.

6. You use at least four consecutive sweeps for determining the vertical visibility into a surface-based obscuring phenomenon.

8. Values of more than 10 times the baseline of the RBC or ceiling light may be used as estimated heights. Values less than 10 times the baseline are used as measured heights.

9. Height indications from the RHI scope are unreliable below 10,000 to 12,000 feet.

10. An indefinite ceiling is the distance you can see vertically into the obscuring phenomenon.

(1-1-9)

1. a. 8 SCT M13V BKN.

b. CIG 12V14.

c. 1800.

2. a. 3 SCT M6 OVC.

b. VIRGA W.

c. 172/.

3. a. 1 SCT 17 SCT E24 BKN 190 BKN 420 OVC.

b. CBMAM W MOVG SE TCU E.

c. 1963

4. a. 5 SCT 14 SCT 65 SCT 95 SCT E130 BKN 210 BKN 220 OVC.

b. TCU E ACCAS E.

c. 1289

5. a. 17 SCT 170 SCT.

b. CB W ACSL E.

c. 1940

(1-1-9) Cont.

6. a. M2 BKN 70 BKN.
   b. 2 BKN V SCT.
   c. 1610
7. a. 10-SCT 33-BKN.
   b. K 10 -SCT.
   c. 1100.
8. a. E7 BKN 70 BKN.
   b. BRKS NE.
   c. 1610
9. a. E10 BKN 35 OVC.
   b. (None).
   c. 16//.
10. a. E130 BKN 460 BKN.
    b. (None).
    c. 1077

(1-1-10)

1. 400 feet.
2. (1) When clouds are present within the measuring capability of the set or fog is present.

   (2) When either of the above conditions is forecasted within three hours.

   (3) When a local need exists.
3. Position 5—sweep should appear at 0°. Adjust with SWEEP LENGTH control.

   Position 4—sweep should appear at 90°. Adjust with SWEEP LENGTH control.

   Position 3—sweep should appear at 45°. Adjust with VERT CENTER control.

   Position 2—sweep flashes in each rectangle on the scale (18° markers). If not repeat adjustments for positions 5, 4, and 3.

   Position 1—sweep should trace 0° to 90°. If not, repeat above adjustments. Adjust HORIZ GAIN control until sweep is about 1/8-inch wide.
4. Proceed with the calibration as listed in the answer above. Synchronize the projector and sweep.
5. One.
6. It synchronizes the sweep with the projector.

(1-1-10) Cont.

7. The baseline is the major limiting factor.
8. Every fourth sweep.
9. Every other sweep or approximately every six seconds.

(1-1-11)

1. a. 62° b. 800′.
2. a. 63° b. 800′.
3. a. 15° b. 100′.
4. a. 25° and 76° b. 200′ and 1,600′.

(1-1-12)

1. The ceiling light can be used at night only.
2. The six steps in determining heights with a clinometer are:
   (1) Loosen the pendant clutch so the pendant will swing freely.
   (2) Sight through the clinometer and center the crosshair on the brightest portion of the light beam spot on the cloud base. For vertical visibility into obscuring phenomenon, sight on the upper limit of the light beam.
   (3) Lock pendant clutch without moving clinometer or pendant.
   (4) Read the angle to the nearest degree and release the pendant clutch.
   (5) Repeat steps 1 through 4 three times and average the readings.
   (6) Refer to the table applicable to the baseline used in obtaining the height value for the average reading.

(1-1-13)

1. Col 3. 8NS085.
2. Col 3. 2AC085 1CI190.
3. Col 3. 2FG///8ST018.

(1-1-14) 2, 3, 6, and 8 are good day markers; 1 and 7 are good night markers; 4 can be used at night only to estimate visibility; 5 may be used as a day marker but it is poor because of its color.

(1-1-15)

1. Prevailing visibility is the greatest distance that known objects can be seen and identified throughout half or more of the horizon surrounding the station.
2. When your station is such that your view of portions of the horizon is obstructed.
3. Eight compass points are normally used to report sector visibility. They are N, NE, E, SE, S, SW, W, and NW.
4. Column 4, IV column 13, VSBY 5/8V1 1/2.

(1-1-15) Cont.

5. (1) When sector visibility differs from prevailing visibility.

   (2) When the sector visibility is less than three miles.

6. TWR VSBY 2 should be entered in column 13.

7. Sectors are listed in a clockwise direction.

8. Yes, if you consider it operationally significant.

9. a. Column 4, 6.
   b. Column 4, 3 Column 13, VSBY SE2.

(1-1-16)

1. When the transmissivity is less than 15 percent.

2. The HIGH setting increases the reading by a multiple of 5. If you do not divide by 5, you will have an erroneous RVR computation.

LESSON 2

(1-2-1)

1. Funnel cloud.

2. Waterspout.

3. Tornado.

4. a. (no entry)
   b. PILOT FUNNEL CLOUD 25 SW NGU MOVG NE 1630

5. a. TORNADO
   b. TORNADO W MOVG NE

6. a. (no entry)
   b. FUNNEL CLOUD B30-E 35 NE DISPTD

(1-2-2)

1. When hail is falling or lightning is observed in the immediate vicinity of your station and the local noise level prevents you from hearing the thunder.

2. a. T + A
   b. T OVHD MOVG SE OCNL LTGCC FQT LTGCG SE HLSTO 1 1/2

3. a. (no entry)
   b. T B30E55 MOVD E OCNL LTGCC

(1-2-3)

1. Rain and drizzle.

2. Freezing precipitation is liquid precipitation that falls and freezes upon impact with objects on the surface or in flight.

3. (a) Ice pellets
   (b) snow gains
   (c) snow
   (d) hail
   (e) ice crystals
   (f) snow pellets

(1-2-4)
1. Continuous, intermittent, and showery.
2. Continuous.
3. Showery.
4. Intermittent.
5. Showery.
6. (a) heavy show
   (b) moderate ice pellets
   (c) light rain
   (d) light drizzle

(1-2-5)
1. a. Observe and record the digital display readout or count the marks on the right side margin of the analog recorder chart.
   b. Observe and record the amount in the measuring tube, empty that and then measure any overflow by pouring from the overflow can into the measuring tube.
2. Remove the collector-funnel unit and measuring tube.
3. Pour a measured amount of warm water into the overflow can to melt the solid precipitation, pour the melted liquid into the measuring tube, measure the total amount and subtract the amount of warm water used.
4. 1.10
5. 0.15
6. 0.44

(1-2-6)

1.	a. app00	b. app12	c. app03 TWO
2.	a. 90405	b. No entry required	c. 90499 90412
3.	a. No entry required	b. 20012	c. 21002

(1-2-7)
1. Fog, ground fog, blowing snow, ice fog, and blowing spray.
2. Dust, blowing dust, blowing sand, haze, and smoke.
3. a. Fog
   b. drifting snow
   c. blowing sand
   d. smoke

(1-2-8)
1. a. 8
   b. T
   c. T 10 NE MOVG E OCNL LTGIC RWU NE
2. a. 1
   b. S-BS
   c. VSBY N 3/4 W 1/2
3. a. 0
   b. ZR-SF
   c. F1 VSBY NE 1/16
4. a. 4
   b. BD
   c. TWR VSBY 6

(1-2-9) 1.

CNOC 3140/11 REV. (1—80) 0108—LF—031—4055

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10) LATITUDE LO

METAR (ABRIDGED FORM FOR MILITARY USE)

TYPE (1)	TIME (GMT) (2)	WIND DRCTN (true) (9)	WIND SPEED (knots) (10)	MAX WIND (knots) (11)	VISIBILITY PREVAILING MILES (4A)	VISIBILITY PREVAILING METERS (4B)	RUNWAY VISUAL RANGE LOCAL (feet or miles) (4C)	RUNWAY VISUAL RANGE LONG-LINE (meters) (4D)	WEATHER AND OBSTRUCTIONS TO VISION LOCAL (5A)	WEATHER AND OBSTRUCTIONS TO VISION LONG-LINE (5B)
				a.	4	6000	R03VR60	R1830	RASH-	80RASH
				b.	0.25	0500	R36VR10	R0300	FG	45FG
				c.	3	4800				

Hrs / Hrs	MAG TO TRUE + Deg − Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

ALSTG (inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating preceding data, coded additive data group (if specified) radiosonde data, runway conditions, weather modification.) (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)
b.	VIS NE 0.5				
c.	VIS E 2½ RASHE FG BANK W				

LESSON 3

(1-3-1)

1. (e)	5. (a)	8. (b)
2. (h)	6. (f)	9. (j)
3. (d)	7. (g)	10. (c)
4. (i)		

(1-3-2)

1. Display module	4. Register and record	7. Millibars
2. Millibars	5. Land	8. Inch
3. Reduce	6. Shipboard	9. 0.005

(1-3-3)

1. (j)	5. (k)	9. (b)
2. (a)	6. (c)	10. (i)
3. (f)	7. (h)	11. (e)
4. (g)	8. (d)	

(1-3-4)

1. Fahrenheit	4. −20 °F to +120 °F
2. Free air or Drybulb and Wetbulb	5. Highest
3. Muslin wick	6. Lowest

(1-3-5)

1. High	4. Wind	7. Drybulb
2. Whole	5. No	8. Above
3. Drybulb	6. Wetbulb	9. Below

(1-3-6)

1. Whole	4. M	6. Whole
2. Whole	5. Tenth	7. Celsius
3. 24		

(1-3-7)

1. Windspeed, Relative Humidity, Insolation	5. 120
	6. 108
2. −5	7. Temperature
3. −15	8. Lethal
4. Heat Stress	9. Safe

(1-3-8)

1. (f)	4. (g)	7. (d)
2. (b)	5. (c)	8. (a)
3. (i)	6. (h)	9. (e)

(1-3-9)

1. 14	3. Apparent	5. Maneuvering, plotting
2. 60	4. Apparent, ships	

(1-3-10)	**1. One**	**4. 25**	**7. Degree**
	2. Tens	**5. Day**	**8. GMT**
	3. Whole	**6. Knot**	

LESSON 4

(1-4-1) 1. a. Wrong order of entry in column 5; column 12 should be entered in three digits—992.

b. Intensity of snow not in agreement with visibility; column 12 should be entered in three digits—995.

c. Dewpoint can never be higher than the temperature.

d. Column 5 should be T + RW because of winds more than 50 knots.

e. No intensity is assigned to hail; column 12 should be entered in three digits—002.

f. Visibility of less than 7 miles requires an entry in column 5; also requires entries in columns 6, 7, 8, 9, 10, and 12.

2. a. Need three digits for wind direction; column 4B does not agree with column 4A, 4B should also be in four digits—0800; should have entries in columns 4C and 4D; column 5A should be HZ, column 5B should be as entered in column 5A; height of cloud in the sky condition column is wrong—should read 5SC030; column 12 should be entered in four digits—2992; the Remarks column should have a ceiling remark.

b. Enter wind direction as 000 for calm wind; column 4B should be in four digits; column 12 should be entered in four digits; the Remarks column requires no remark for ceilings above 3,000 feet.

c. Column 11 must exceed column 10 by 5 knots to be entered; column 4B does not agree with column 4A; column 12 should be entered in four digits; the Remarks column does not require a CIG NO remark unless total sky cover is 5/8 or more.

d. Enter wind direction in three digits, windspeed should be in two digits; column 4B is entered in four digits; column 5A should be FG, column 5B should be as entered in 5A; column 12 should be entered in four digits.

e. Column 10 should be entered in two digits; column 4B does not agree with 4A; column 5A should be RESH, column 5B should be as entered in 5A; column 12 should be entered in four digits.

3. RADAT 84M019045056/2.

(1-4-2)

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FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10)
METAR (ABRIDGED FORM FOR MILITARY USE)

LATITUDE | LONGITUDE | STATION ELE | MAG TO TRUE ° Deg | DAY (LST) | MONTH | YEAR | STATION AND STATE OR COUNTRY

	TYPE (1)	TIME (GMT) (2)	WIND DRCTN (true) (9)	WIND SPEED (knots) (10)	MAX WIND (knots) (11)	VISIBILITY PREVAILING MILES (4A)	VISIBILITY PREVAILING METERS (4B)	RUNWAY VISUAL RANGE LOCAL (feet or miles) (4C)	RUNWAY VISUAL RANGE LONG-LINE (meters) (4D)	WEATHER AND OBSTRUCTIONS TO VISION LOCAL (5A)	WEATHER AND OBSTRUCTIONS TO VISION LONG-LINE (5B)	SKY COND (3)	REMARKS AND SUPPLEMENTAL CODED DATA (All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating precoding data, coded additive data group (if specified) radiosonde data, runway conditions, weather modification.) (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (8)	TOTAL SKY COVER (21)	OBS INIT (15)
a.	SA	1957	200	15		3	4800			TS RASH	95TS	4CB016 3SC016	CIGM016 VIS SW1 1/2 TS OVHD				
													MOV NW FQT LTGIC			7	HH
b.	SP	2003	220	21	26	2 1/2	4000			TS+RASH							
										GR	99XX		CIGM014 VIS SW1 TS OVHD				
											TSGR	3CB014 4SC014	MOV NE GRB03 HLSTO 3/4				HH
													CIGM012 VIS SE 2 1/2 SW1				
c.	SP	2014	220	21	26	3				TS RASH	95TS	5CB012 3SC012	TS OVHD MOV NE GRE14				
													HLSTO 3/4				HH

(1-4-2) **2.**

CNOC 3140/7 REV.(10-79) 0108-LF-031-4037

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10) (ABRIDGED FORM FOR MILITARY USE)	LATITUDE	LONGITUDE	STATION ELEVATION (Hg) FEET (MSL)	TIME CONVERSION LST to GMT) + − Hrs Hrs	MAG TO TRUE + − Deg Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

	TYPE (1)	TIME (GMT) (2)	SKY CONDITION (3)	PVLG VSBY (miles) (4)	WEATHER AND OBSTNS TO VISION (5)	SEA LEVEL PRES (mb) (6)	TEMP (°F) (7)	DEW-POINT (°F) (8)	WIND DRCTN (true) (9)	WIND SPEED (knots) (10)	WIND CHARACTER (knots) (11)	ALSTG (inches) (12)	REMARKS AND SUPPLEMENTARY CODED DATA. DESIRED ORDER OF ENTRY: RVR, SFC based obsc phenomena, remarks elaborating on preceding coded data 3- and 6-hourly additive data, radiosonde data, runway conditions, weather modification (13)
a.	SA	1855	M18 BKN	8					21	12			CB SW MOVG NW
b.	SP	1917	E18 BKN	7	T				19	24	G29		T SW MOVG NE OCNL LTGICCG
c.	SP	1922	M17 BKN	7	TRW-				19	18	G22		VSBY SW2 T SW MOVG NE OCNL LTGIC

(1-4-3) 1.

a. RS, hourly observation.
b. SP, ice pellets began.
c. L (no specified requirement).
d. SP, snow begun.
e. SP, ice pellets ended.
f. RS, ceiling increased to 500′ and hourly observation.
g. SP, ceiling decreased to less than 500+.
h. SP, ceiling increased to above 1,000′.
i. SP, ceiling decreased to less than 1,000′, ice pellets begun.
j. L (no specified requirement).
k. SP, ice pellets ended, freezing precipitation begun.
l. SA, hourly observation.
m. SP, freezing precipitation ended, precipitation begun.
n. L (no specified requirement).
o. SP, precipitation ended.
p. SP, ceiling increased to above 1,000′.
q. SP, precipitation begun.
r. RS, hourly observation, visibility increased to 1 mile, thunderstorm begun.
s. SP, visibility increased to 2 miles.
t. SP, visibility decreased to less than 1 1/2 miles.
u. SP, hail begun, visibility decreased to less than 1 mile.
v. SP, hail ended.
w. RS, hourly observation, visibility increased to 3 miles and ceiling increased to 1,500 feet.
x. SP, thunderstorm ended.
y. SP, ceiling increased to 4,500 feet.
z. L (no specified requirement).
aa. SP, precipitation ended.
bb. SA, hourly observation.

2.

a. SA, hourly observation.
b. SP, precipitation began, ceiling decreased to less than 3,000′.
c. SA, hourly observation.
d. SP, thunderstorm begun, ceiling decreased to less than 1,000′.
e. SP, windspeed doubled, thunderstorm increased in intensity.
f. RS, hourly observation, thunderstorm ended, ceiling increased to greater than 3,000′.
g. RS, hourly observation, precipitation ended.

(1-4-4) 1. (a) D (b) A (c) B (d) C

(1-4-5) 1. (a) Facing (b) Sighting along (c) From (d) 3

(1-4-6) 1. B 2. D 3. B 4. C

(1-4-7)

1. S	5. L	9. S
2. L	6. SL	10. S
3. S	7. S	11. L
4. S	8. L	

(1-4-8)

1. **DOMESTIC:** NEL UA /OV PNE 135006 0000 FL 070/TP DC3/SK 036 BKN 066/RM OVC ABV

   OVERSEAS: (CCCC) PIREP 6SE (CCCC) 0000 036 BKN 066 INC ABV

2. **DOMESTIC:** NTU UA /OV NBG 0200 FL 015/TP P3/TB LGT/RM WIND SHEAR

   OVERSEAS: (CCCC) PIREP OVR (CCCC) 0200 NBG TURB WIND SHEAR 015 P3

3. **DOMESTIC:** DYS UA /OV ABI 163003 0223 FL 310/TP C141/SK INC/TB LGT/MDT

   OVERSEAS: (CCCC) PIREP OVR (CCCC) 0223 FBL-MOD TURB INC 310 C141

UNIT 2

LESSON 1

(2-1-1)

WAVE HEIGHT OBSERVATIONS

P = PLUNGING
S = SPILLING
X = SURGING

TIME BEGAN 09 MIN 20 SEC

4.5s	4.0s	3.0s	4.5p	4.0s
4.5s	3.0s	2.5s	4.5p	3.5s
5.0p	2.0s	3.5s	3.5s	4.5s
3.5s	2.5s	4.0s	3.0s	5.0p
4.0s	4.0s	3.5s	4.0s	4.0s
4.5p	4.5p	3.5s	3.5s	4.0s
5.0p	3.5s	3.5s	3.5s	3.5s
5.5p	2.0s	3.5s	4.5s	4.5p
4.0s	1.5s	4.0s	5.0p	4.0s
3.0s	2.0s	4.5p	5.0p	3.5s
2.5s	4.0s	4.0s	5.5p	3.0s
3.0s	4.5p	3.5s	4.5s	4.0s
3.5s	5.0p	3.0s	2.5s	3.5s
4.5p	6.5p	4.0s	3.5s	4.5s
5.5p	6.0p	4.5p	4.0s	4.5s
6.0p	4.5s	5.0p	4.5p	4.0s
5.5p	5.0s	4.5s	4.0s	4.5p
5.0s	4.5s	4.0s	3.5s	4.5p
4.5p	4.5p	4.0s	3.0s	4.0s
4.5p	4.0s	4.0s	3.5s	4.0s

TIME ENDED 23 MIN 30 SEC

WAVE PERIOD COMPUTATION

ELAPSED TIME 14 MIN 10 SEC

TOTAL SECONDS = 850 / 100 = 8.50 CHARLIE

NOTE: (ECHO - FOXTROT)
RIGHT OR LEFT FLANK AS SEEN FROM SEAWARD

SURF OBSERVATION REPORT

SUROB NO ONE YELLOW BEACH

08 APRIL 0015 L
DAY-TIME OF OBSERVATION

ALFA 5 PT 0
SIGNIFICANT BREAKER = AVERAGE OF HIGHEST ONE THIRD TO NEAREST HALF FOOT

BRAVO 6 PT 5
MAXIMUM BREAKER = NEAREST HALF FOOT

CHARLIE 8 PT 5
PERIOD = FIVE TENTHS OF A SECOND

DELTA 29 PLUNGING 71 SPILLING
____ SURGING
BREAKER TYPE: PERCENT APPLICABLE

ECHO 30 TOWARD L FLANK ± 10°
RIGHT/LEFT (SEE NOTE)
BREAKER ANGLE = ACUTE ANGLE THAT BREAKER MAKES WITH BEACH

FOXTROT 0 PT 6 KT ____ TOWARD L FLANK ± 0.1 KTS.
RIGHT/LEFT (SEE NOTE)
LITTORAL CURRENT = MEASURED TO NEAREST TENTH OF A KNOT ONE KNOT = 100 FT PER MINUTE

GOLF 1 TO 2 LINE IN 65 FT
SURF ZONE
SURF ZONE = PREDOMINANT NUMBER OF BREAKERS IN, AND WIDTH OF

HOTEL VSBY SEAWARD 3 MILES HAZE
VSBY INLAND 2 MILES FOG/HAZE
REL WIND 030 RF 20 KTS
PERTINENT REMARKS = WIND - WEATHER - VISIBILITY SECONDARY WAVE SYSTEM ETC.

WAVE HEIGHT COMPUTATION

FOR HIGHEST 33 WAVES

HEIGHT	X	OCCURANCE	=	PRODUCT
6.5	X	1	=	6.5
6.0	X	2	=	12.0
5.5	X	4	=	22.0
5.0	X	9	=	45.0
4.5	X	17	=	76.5
	X		=	

TOTAL = 162.5 / 33 = 4.9 = ALFA

LESSON 2

(2-2-1)	1. Checked	2. Socket	3. Contact	4. Left	5. 25°C

(2-2-2)	1. 10	4. Left	6. Above
	2. 10	5. Left	7. Parentheses
	3. Additional		

(2-2-3)	1. Recorder record	2. Data block	3. Possible

LESSON 3

(2-3-1)	1. Speed	2. PIBAL	3. RABAL	4. RAWIN	5. Six

(2-3-2)	1. Paper tape	4. Ten	7. 0.1
	2. Asterisk	5. 0.05	8. 10
	3. Baroswitch	6. 12.0	

(2-3-3)	1. Azimuth	2. 100	3. One-tenth	4. Counterweight

UNIT 3

LESSON 1

(3-1-1)	1. c 2. f 3. j 4. d	5. h 6. e 7. a	8. g 9. i 10. b
(3-1-2)	1. d 2. f 3. a 4. i	5. e 6. c 7. h	8. j 9. b 10. g
(3-1-3)	1. b 2. f 3. c	4. g 5. e	6. d 7. a
(3-1-4)	1. d 2. h 3. e 4. k	5. f 6. j 7. g 8. l	9. a 10. c 11. b
(3-1-5)	1. f 2. c 3. h	4. a 5. i 6. b	7. g 8. d 9. e
(3-1-6)	1. f 2. j 3. g 4. b	5. k 6. h 7. d 8. e	9. a 10. c 11. i
(3-1-7)	1. e 2. a 3. f 4. j 5. g	6. b 7. l 8. m 9. i	10. c 11. h 12. k 13. d

LESSON 2

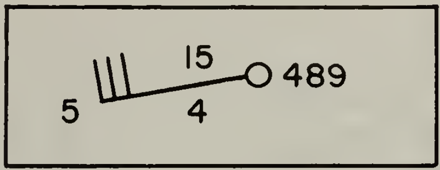
(3-2-1)	1. a 2. d 3. c	4. c 5. a	6. c 7. b

LESSON 3

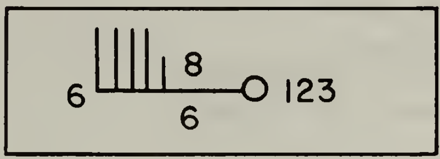
(3-3-1)	1. Isotherms, celsius temperature 2. One, five 3. (c)	4. (a) 5. (d)

LESSON 4

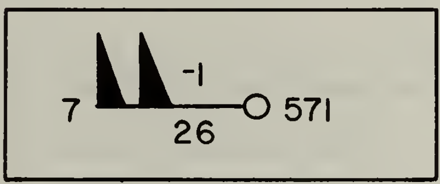
(3-4-1) 1.



2.



3.



(3-4-2) 1. c

LESSON 5

(3-5-1) 1. a. navigation
b. naval operations
c. weather forecasting
d. commercial fishing
2. c
3. a. −0.3°C
b. 14.8°C
c. 11.1°C
4. b
5. c
6. A depiction of accurate temperature versus depth information for a particular water column at a given location (or words to that effect).
7. 23.9°C
8. 8.1°C

LESSON 6

(3-6-1) 1. 466
2. 21:31:40
3. 12.83 E
4. 1:55:00
5. 28.75
6. 23:26:40
7. 41.58

(3-6-2) 1. 34
2. 1430
3. 92.2° 121.1°W

LESSON 7

(3-7-1)

1. a. 4 Jan 12Z
   b. 40°N 75°W
   c. DELTA, BRAVO
   d. 12 NM 184 NM
   e. 260° 14 kns
   f. 18 NM 205 NM
   g. 45°N 75°W
      Low BRAVO High ECHO
      250° 45 kns 250° 41 kns
      19 NM
   h. 24 hr
2. a. 13Z
   b. 37°N 76°W
   c. 10,000 kt (or 10MT)
   d. 430 mi

LESSON 8

(3-8-1)	1. d	5. h	8. e
	2. f	6. j	9. c
	3. i	7. a	10. g
	4. b		

(3-8-2)	1. k	5. a	9. g
	2. b	6. j	10. e
	3. i	7. l	11. f
	4. d	8. h	12. c

(3-8-3)	1. e	3. c	5. b
	2. d	4. a	

(3-8-4)	1. g	5. e	8. c
	2. i	6. b	9. j
	3. f	7. a	10. d
	4. h		

LESSON 9

(3-9-1)	1. d	5. h	8. b
	2. f	6. j	9. c
	3. i	7. e	10. g
	4. a		

(3-9-2)	1. b	5. g	8. d
	2. e	6. j	9. i
	3. c	7. a	10. h
	4. f		

UNIT 4

LESSON 1

(4-1-1)

1. a. (7) d. (2) g. (5)
   b. (8) e. (1) h. (4)
   c. (3) f. (6)

2. a. (AK) b. (NT) c. (CN)

3. a. (AIRMET) b. (SIGMET WS) c. (SIGMET WST)

LESSON 2

(4-2-1)

1. (b)

2. a. Warm front at surface
   b. Cold front at surface
   c. Cold front frontogenesis
   d. Occluded front at surface
   e. Warm front frontolysis
   f. Quasi-stationary front at surface
   g. Instability line

3.

	SHADING	SHADING COLOR	SYMBOL and COLOR	
a.	None	None	$\overset{*}{\nabla}$	Green
b.	Solid	Yellow	≡	Yellow
c.	Solid	Green	,,	Green
d.	None	None	☈	Red
e.	Solid	Brown	∞	Brown
f.	Hatching	Green	*	Green

4. (a)
5. (d)
6. (d)

UNIT 5

LESSON 1

(5-1-1)	1. Air temperature	2. Pressure	3. Dew-point	4. Rainfall
(5-1-2)	1. Six	2. Wind speed	3. 120	4. 140

(5-1-3)	1. 910 to 1060 Mb	4. Soft rag	7. North
	2. Eight	5. Batteries	8. Hundredth
	3. Four	6. Three	
(5-1-4)	1. 500	3. 800	5. 90
	2. 100	4. Ten	
(5-1-5)	1. Operational	3. Standardize	5. 3140.1
	2. Planning	4. 4790.4	

LESSON 2

(5-2-1)	1. AN/GMD-1( )	4. Battery	6. 70
	2. AN/TMQ-5( )	5. Balloon	7. High
	3. AN/SMQ-1( )		

LESSON 3

(5-3-1)	1. Radar	3. Range	5. Eight
	2. PPI	4. 200	6. PPI

LESSON 4

(5-4-1)	1. a	5. k	9. d
	2. f	6. j	10. e
	3. g	7. b	11. c
	4. i	8. h	

UNIT 6

LESSON 1

(6-1-1)
1. (a) ROUTINE RR
   (b) PRIORITY PP
   (c) IMMEDIATE OO
   (d) FLASH ZZ
   (ANY ORDER)
2. Punctuation is never used (or words to that effect)
3. (a) TG SEVEN ZERO PT FIVE (or something similar)
   (b) AIG THREE ZERO FOUR NINE (or any AIG)
4. (a) UNCLAS (no spaces)
   (b) S E C R E T (must have spaces)
5. (4)
6. In a classified message, each paragraph must be numbered and classified by its content. Example:
   1. (S) etc.
   (or words to that effect)

(6-1-2)
1. Alignment is achieved by adjusting the form so that a typed character will print between the double print in the upper left or right hand margin of the form.
   (or words to that effect)
2. The message is cancelled at the time indicated.
   (or words to that effect)
3. (4)
4. (3)

(6-1-3)
1. (2)
2. Page Numbering
   Precedence
   Classification (two places)
   ORIG/MSG IDENT
   (any order)

(6-1-4)
1. TACTICAL SUPPORT PRODUCTS MANUAL (U) VOLUME I AND II NAVOCEANCOMINST C3140.22
2. TACTICAL SUPPORT PRODUCTS MANUAL (U) VOLUME I AND II NAVOCEANCOMINST C3140.22

LESSON 2

(6-2-1) 1. High speed 2. 24 3. 69 4. New line

(6-2-2) 1. Accurately 2. Teletype 3. Maps 4. Several

(6-2-3)
1. One
2. Kansas City, MO
3. A
4. C
5. O
6. Satellite
7. Aviation

(6-2-4)	**1. Commanding officer**	**4. Deactivate**	**7. 70**
	2. Respiratory Block	**5. Never**	**8. Commanding officer**
	3. OFF	**6. One**	**9. Base**

LESSON 3

(6-3-1)	**1. Colors**	**2. Weather**	**3. 10 to 15**

APPENDIX II

THE METRIC SYSTEM AND CONVERSION TABLES

THE METRIC SYSTEM

U.S. CUSTOMARY AND METRIC SYSTEM UNITS OF MEASUREMENTS

THESE PREFIXES MAY BE APPLIED TO ALL SI UNITS

Multiples and Submultiples	Prefixes	Symbols
1 000 000 000 000 = 10^{12}	tera (tĕr'å)	T
1 000 000 000 = 10^{9}	giga (jĭ'gå)	G
1 000 000 = 10^{6}	mega (mĕg'å)	M •
1 000 = 10^{3}	kilo (kĭl'ô)	k •
100 = 10^{2}	hecto (hĕk'tô)	h
10 = 10	deka (dĕk'å)	da
0.1 = 10^{-1}	deci (dĕs'ĭ)	d
0.01 = 10^{-2}	centi (sĕn'tĭ)	c •
0.001 = 10^{-3}	milli (mĭl'ĭ)	m •
0.000 001 = 10^{-6}	micro (mī'krô)	μ •
0.000 000 001 = 10^{-9}	nano (năn'ô)	n
0.000 000 000 001 = 10^{-12}	pico (pē'kô)	p
0.000 000 000 000 001 = 10^{-15}	femto (fĕm'tô)	f
0.000 000 000 000 000 001 = 10^{-18}	atto (ăt'tô)	a

• MOST COMMONLY USED

COMMON EQUIVALENTS AND CONVERSIONS

Approximate Common Equivalents

1 inch	= 25 millimeters
1 foot	= 0.3 meter
1 yard	= 0.9 meter
1 mile	= 1.6 kilometers
1 square inch	= 6.5 square centimeters
1 square foot	= 0.09 square meter
1 square yard	= 0.8 square meter
1 acre	= 0.4 hectare †
1 cubic inch	= 16 cubic centimeters
1 cubic foot	= 0.03 cubic meter
1 cubic yard	= 0.8 cubic meter
1 quart (lq.)	= 1 liter †
1 gallon	= 0.004 cubic meter
1 ounce (avdp)	= 28 grams
1 pound (avdp)	= 0.45 kilogram
1 horsepower	= 0.75 kilowatt
1 millimeter	= 0.04 inch
1 meter	= 3.3 feet
1 meter	= 1.1 yards
1 kilometer	= 0.6 mile
1 square centimeter	= 0.16 square inch
1 square meter	= 11 square feet
1 square meter	= 1.2 square yards
1 hectare †	= 2.5 acres
1 cubic centimeter	= 0.06 cubic inch
1 cubic meter	= 35 cubic feet
1 cubic meter	= 1.3 cubic yards
1 liter †	= 1 quart (lq.)
1 cubic meter	= 250 gallons
1 gram	= 0.035 ounces (avdp)
1 kilogram	= 2.2 pounds (avdp)
1 kilowatt	= 1.3 horsepower

† common term not used in SI

Conversions Accurate to Parts Per Million

inches x 25.4*	= millimeters
feet x 0.3048*	= meters
yards x 0.9144*	= meters
miles x 1.609 344	= kilometers
square inches x 6.4516*	= square centimeters
square feet x 0.092 903	= square meters
square yards x 0.836 127	= square meters
acres x 0.404 686	= hectares
cubic inches x 16.387 064	= cubic centimeters
cubic feet x 0.028 317	= cubic meters
cubic yards x 0.764 555	= cubic meters
quarts (lq.) x 0.946 353	= liters
gallons x 0.003 785	= cubic meters
ounces (avdp) x 28.349 523	= grams
pounds (avdp) x 0.453 592	= kilograms
horsepower x 0.745 7	= kilowatts
millimeters x 0.039 37	= inches
meters x 3.280 84	= feet
meters x 1.093 613	= yards
kilometers x 0.621 371	= miles
square centimeters x 0.155	= square inches
square meters x 10.76391	= square feet
square meters x 1.195 99	= square yards
hectares x 2.471054	= acres
cubic centimeters x 0.061 024	= cubic inches
cubic meters x 35.31467	= cubic feet
cubic meters x 1.307 951	= cubic yards
liters x 1.056 688	= quarts (lq.)
cubic meters x 264.172	= gallons
grams x 0.035 274	= ounces (avdp)
kilograms x 2.204 623	= pounds (avdp)
kilowatts x 1.341 02	= horsepower

* exact

Temperature Conversion
Fahrenheit (F) to Celsius (C) Degrees

$F = \frac{9}{5} C + 32$ or $F = 1.8\,C + 32$

$C = \frac{5}{9} (F - 32)$ or $C = \frac{F - 32}{1.8}$

°F.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
+120	+48.89	+48.94	+49.00	+49.06	+49 11	+49.17	+49.22	+49.28	+49.33	+49.39
119	48.33	48.39	48.44	48.50	48.56	48.61	48.67	48.72	48.78	48.83
118	47.78	47.83	47.89	47.94	48.00	48.06	48.11	48.17	48.22	48.28
117	47.22	47.28	47.33	47.39	47.44	47.50	47.56	47.61	47.67	47.72
116	46.67	46.72	46.78	46.83	46.89	46.94	47.00	47.06	47.11	47.17
+115	+46.11	+46.17	+46.22	+46.28	+46.33	+46.39	+46.44	+46.50	+46.56	+46.61
114	45.56	45.61	45.67	45.72	45.78	45.83	45.89	45.94	46.00	46.06
113	45.00	45.06	45.11	45.17	45.22	45.28	45.33	45.39	45.44	45.50
112	44.44	44.50	44.56	44.61	44.67	44.72	44.78	44.83	44.89	44.94
111	43.89	43.94	44.00	44.06	44.11	44.17	44.22	44.28	44.33	44.39
+110	+43.33	+43.39	+43.44	+43.50	+43.56	+43.61	+43.67	+43.72	+43.78	+43.83
109	42.78	42.83	42.89	42.94	43.00	43.06	43.11	43.17	43.22	43.28
108	42.22	42.28	42.33	42.39	42.44	42.50	42.56	42.61	42.67	42.72
107	41.67	41.72	41.78	41.83	41.89	41.94	42.00	42.06	42.11	42.17
106	41.11	41.17	41.22	41.28	41.33	41.39	41.44	41.50	41.56	41.61
+105	+40.56	+40.61	+40.67	+40.72	+40.78	+40.83	+40.89	+40.94	+41.00	+41.06
104	40.00	40.06	40.11	40.17	40.22	40.28	40.33	40.39	40.44	40.50
103	39.44	39.50	39.56	39.61	39.67	39.72	39.78	39.83	39.89	39.94
102	38.89	38.94	39.00	39.06	39.11	39.17	39.22	39.28	39.33	39.39
101	38.33	38.39	38.44	38.50	38.56	38.61	38.67	38.72	38.78	39.83
+100	+37.78	+37.83	+37.89	+37.94	+38.00	+38.06	+38.11	+38.17	+38.22	+38.28
99	37.22	37.28	37.33	37.39	37.44	37.50	37.56	37.61	37.67	37.72
98	36.67	36.72	36.78	36.83	36.89	36.94	37.00	37.06	37.11	37.17
97	36.11	36.17	36.22	36.28	36.33	36.39	36.44	36.50	36.56	36.61
96	35.56	35.61	35.67	35.72	35.78	35.83	35.89	35.94	36.00	36.06
+95	+35.00	+35.06	+35.11	+35.17	+35.22	+35.28	+35.33	+35.39	+35.44	+35.50
94	34.44	34.50	34.56	34.61	34.67	34.72	34.78	34.83	34.89	34.94
93	33.89	33.94	34.00	34.06	34.11	34.17	34.22	34.28	34.33	34.39
92	33.33	33.39	33 44	33.50	33.56	33.61	33.67	33.72	33.78	33.83
91	32.78	32.83	32.89	32.94	33.00	33.06	33.11	33.17	33.22	33.28
+90	+32.22	+32.28	+32.33	+32.39	+32.44	+32.50	+32.56	+32.61	+32.67	+32.72
89	31.67	31.72	31.78	31.83	31.89	31.94	32.00	32.06	32.11	32.17
88	31.11	31.17	31.22	31.28	31.33	31.39	31.44	31.50	31.56	31.61
87	30.56	30.61	30.67	30.72	30.78	30.83	30.89	30.94	31.00	31.06
86	30.00	30.06	30.11	30.17	30.22	30.28	30.33	30.39	30.44	30.50
+85	+29.44	+29.50	+29.56	+29.61	+29.67	+29.72	+29.78	+29.83	+29.89	+29.94
84	28.89	28.94	29.00	29.06	29.11	29.17	29.22	29.28	29.33	29.39
83	28.33	28.39	28.44	28.50	28.56	28.61	28.67	28.72	28.78	28.83
82	27.78	27.83	27.89	27.94	28.00	28.06	28.11	28.17	28.22	28.28
81	27.22	27.28	27.33	27.39	27.44	27.50	27.56	27.61	27.67	27.72
+80	+26.67	+26.72	+26.78	+26.83	+26.89	+26.94	+27.00	+27.06	+27.11	+27.17
79	26.11	26.17	26.22	26.28	26.33	26.39	26.44	26.50	26.56	26.61
78	25.56	25.61	25.67	25.72	25.78	25.83	25.89	25.94	26.00	26.06
77	25.00	25.06	25.11	25.17	25.22	25.28	25.33	25.39	25.44	25.50
76	24.44	24.50	24.56	24.61	24.67	24.72	24.78	24.83	24.89	24.94

continued

F.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
+75	+23.89	+23.94	+24.00	+24.06	+24.11	+24.17	+24.22	+24.28	+24.33	+24.39
74	23.33	23.39	23.44	23.50	23.56	23.61	23.67	23.72	23.78	23.83
73	22.78	22.83	22.89	22.94	23.00	23.06	23.11	23.17	23.22	23.28
72	22.22	22.28	22.33	22.39	22.44	22.50	22.56	22.61	22.67	22.72
71	21.67	21.72	21.78	21.83	21.89	21.94	22.00	22.06	22.11	22.17
+70	+21.11	+21.17	+21.22	+21.28	+21.33	+21.39	+21.44	+21.50	+21.56	+21.61
69	20.56	20.61	20.67	20.72	20.78	20.83	20.89	20.94	21.00	21.06
68	20.00	20.06	20.11	20.17	20.22	20.28	20.33	20.39	20.44	20.50
67	19.44	19.50	19.56	19.61	19.67	19.72	19.78	19.83	19.89	19.94
66	18.89	18.94	19.00	19.06	19.11	19.17	19.22	19.28	19.33	19.39
+65	+18.33	+18.39	+18.44	+18.50	+18.56	+18.61	+18.67	+18.72	+18.78	+18.83
64	17.78	17.83	17.89	17.94	18.00	18.06	18.11	18.17	18.22	18.28
63	17.22	17.28	17.33	17.39	17.44	17.50	17.56	17.61	17.67	17.72
62	16.67	16.72	16.78	16.83	16.89	16.94	17.00	17.06	17.11	17.17
61	16.11	16.17	16.22	16.28	16.33	16.39	16.44	16.50	16.56	16.61
+60	+15.56	+15.61	+15.67	+15.72	+15.78	+15.83	+15.89	+15.94	+16.00	+16.06
59	15.00	15.06	15.11	15.17	15.22	15.28	15.33	15.39	15.44	15.50
58	14.44	14.50	14.56	14.61	14.67	14.72	14.78	14.83	14.89	14.94
57	13.89	13.94	14.00	14.06	14.11	14.17	14.22	14.28	14.33	14.39
56	13.33	13.39	13.44	13.50	13.56	13.61	13.67	13.72	13.78	13.83
+55	+12.78	+12.83	+12.89	+12.94	+13.00	+13.06	+13.11	+13.17	+13.22	+13.28
54	12.22	12.28	12.33	12.39	12.44	12.50	12.56	12.61	12.67	12.72
53	11.67	11.72	11.78	11.83	11.89	11.94	12.00	12.06	12.11	12.17
52	11.11	11.17	11.22	11.28	11.33	11.39	11.44	11.50	11.56	11.61
51	10.56	10.61	10.67	10.72	10.78	10.83	10.89	10.94	11.00	11.06
+50	+10.00	+10.06	+10.11	+10.17	+10.22	+10.28	+10.33	+10.39	+10.44	+10.50
49	9.44	9.50	9.56	9.61	9.67	9.72	9.78	9.83	9.80	9.94
48	8.89	8.94	9.00	9.06	9.11	9.17	9.22	9.28	9.33	9.39
47	8.33	8.39	8.44	8.50	8.56	8.61	8.67	8.72	8.78	8.83
46	7.78	7.83	7.89	7.94	8.00	8.06	8.11	8.17	8.22	8.28
+45	+7.22	+7.28	+7.33	+7.39	+7.44	+7.50	+7.56	+7.61	+7.67	+7.72
44	6.67	6.72	6.78	6.83	6.89	6.94	7.00	7.06	7.11	7.17
43	6.11	6.17	6.22	6.28	6.33	6.39	6.44	6.50	6.56	6.61
42	5.56	5.61	5.67	5.72	5.78	5.83	5.89	5.94	6.00	6.06
41	5.00	5.06	5.11	5.17	5.22	5.28	5.33	5.39	5.44	5.50
+40	+4.44	+4.50	+4.56	+4.61	+4.67	+4.72	+4.78	+4.83	+4.89	+4.94
39	3.89	3.94	4.00	4.06	4.11	4.17	4.22	4.28	4.33	4.39
38	3.33	3.39	3.44	3.50	3.56	3.61	3.67	3.72	3.78	3.83
37	2.78	2.83	2.89	2.94	3.00	3.06	3.11	3.17	3.22	3.28
36	2.22	2.28	2.33	2.39	2.44	2.50	2.56	2.61	2.67	2.72
+35	+1.67	+1.72	+1.78	+1.83	+1.89	+1.94	+2.00	+2.06	+2.11	+2.17
34	+1.11	+1.17	+1.22	+1.28	+1.33	+1.39	+1.44	+1.50	+1.56	+1.61
33	+.56	+.61	+.67	+.72	+.78	+.83	+.89	+.94	+1.00	+1.06
32	.00	+.06	+.11	+.17	+.22	+.28	+.33	+.39	+.44	+.50
31	-.56	-.50	-.44	-.39	-.33	-.28	-.22	-.17	-.11	-.06
+30	-1.11	-1.06	-1.00	-.94	-.89	-.83	-.78	-.72	-.67	-.61
29	1.67	1.61	1.56	1.50	1.44	1.39	1.33	1.28	1.22	1.17
28	2.22	2.17	2.11	2.06	2.00	1.94	1.89	1.83	1.78	1.72
27	2.78	2.72	2.67	2.61	2.56	2.50	2.44	2.39	2.33	2.28
26	3.33	3.28	3.22	3.17	3.11	3.06	3.00	2.94	2.89	2.83
+25	-3.89	-3.83	-3.78	-3.72	-3.67	-3.61	-3.56	-3.50	-3.44	-3.39
24	4.44	4.39	4.33	4.28	4.22	4.17	4.11	4.06	4.00	3.94
23	5.00	4.94	4.89	4.83	4.78	4.72	4.67	4.61	4.56	4.50
22	5.56	5.50	5.44	5.39	5.33	5.28	5.22	5.17	5.11	5.06
21	6.11	6.06	6.00	5.94	5.89	5.83	5.78	5.72	5.67	5.61

continued

°F.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
+20	-6.67	-6.61	-6.56	-6.50	-6.44	-6.39	-6.33	-6.28	-6.22	-6.17
19	7.22	7.17	7.11	7.06	7.00	6.94	6.89	6.83	6.78	6.72
18	7.78	7.72	7.67	7.61	7.56	7.50	7.44	7.39	7.33	7.28
17	8.33	8.28	8.22	8.17	8.11	8.06	8.00	7.94	7.89	7.83
16	8.89	8.83	8.78	8.72	8.67	8.61	8.56	8.50	8.44	8.39
+15	-9.44	-9.39	-9.33	-9.28	-9.22	-9.17	-9.11	-9.06	-9.00	-8.94
14	10.00	9.94	9.89	9.83	9.78	9.72	9.67	9.61	9.56	9.50
13	10.56	10.50	10.44	10.39	10.33	10.28	10.22	10.17	10.11	10.06
12	11.11	11.06	11.00	10.94	10.89	10.83	10.78	10.72	10.67	10.61
11	11.67	11.61	11.56	11.50	11.44	11.39	11.33	11.28	11.22	11.17
+10	-12.22	-12.17	-12.11	-12.06	-12.00	-11.94	-11.89	-11.83	-11.78	-11.72
9	12.78	12.72	12.67	12.61	12.56	12.50	12.44	12.39	12.33	12.28
8	13.33	13.28	13.22	13.17	13.11	13.06	13.00	12.94	12.89	12.83
7	13.89	13.83	13.78	13.72	13.67	13.61	13.56	13.50	13.44	13.39
6	14.44	14.39	14.33	14.28	14.22	14.17	14.11	14.06	14.00	13.94
+5	-15.00	-14.94	-14.89	-14.83	-14.78	-14.72	-14.67	-14.61	-14.56	-14.50
4	15.56	15.50	15.44	15.39	15.33	15.28	15.22	15.17	15.11	15.06
3	16.11	16.06	16.00	15.94	15.89	15.83	15.78	15.72	15.67	15.61
2	16.67	16.61	16.56	16.50	16.44	16.39	16.33	16.28	16.22	16.17
1	17.22	17.17	17.11	17.06	17.00	16.94	16.89	16.83	16.78	16.72
+0	17.78	17.72	17.67	17.61	17.56	17.50	17.44	17.39	17.33	17.28
-0	-17.78	-17.83	-17.89	-17.94	-18.00	-18.06	-18.11	-18.17	-18.22	-18.28
1	18.33	18.39	18.44	18.50	18.56	18.61	18.67	18.72	18.78	18.83
2	18.89	18.94	19.00	19.06	19.11	19.17	19.22	19.28	19.33	19.39
3	19.44	19.50	19.56	19.61	19.67	19.72	19.78	19.83	19.89	19.94
4	20.00	20.06	20.11	20.17	20.22	20.28	20.33	20.39	20.44	20.50
-5	-20.56	-20.61	-20.67	-20.72	-20.78	-20.83	-20.89	-20.94	-21.00	-21.06
6	21.11	21.17	21.22	21.28	21.33	21.39	21.44	21.50	21.56	21.61
7	21.67	21.72	21.78	21.83	21.89	21.94	22.00	22.06	22.11	22.17
8	22.22	22.28	22.33	22.39	22.44	22.50	22.56	22.61	22.67	22.72
9	22.78	22.83	22.89	22.94	23.00	23.06	23.11	23.17	23.22	23.28
-10	-23.33	-23.39	-23.44	-23.50	-23.56	-23.61	-23.67	-23.72	-23.78	-23.83
11	23.89	23.94	24.00	24.06	24.11	24.17	24.22	24.28	24.33	24.39
12	24.44	24.50	24.56	24.61	24.67	24.72	24.78	24.83	24.89	24.94
13	25.00	25.06	25.11	25.17	25.22	25.28	25.33	25.39	25.44	25.50
14	25.56	25.61	25.67	25.72	25.78	25.83	25.89	25.94	26.00	26.06
-15	-26.11	-26.17	-26.22	-26.28	-26.33	-26.39	-26.44	-26.50	-26.56	-26.61
16	26.67	26.72	26.78	26.83	26.89	26.94	27.00	27.06	27.11	27.17
17	27.22	27.28	27.33	27.39	27.44	27.50	27.56	27.61	27.67	27.72
18	27.78	27.83	27.89	27.94	28.00	28.06	28.11	28.17	28.22	28.28
19	28.33	28.39	28.44	28.50	28.56	28.61	28.67	28.72	28.78	28.83
-20	-28.89	-28.94	-29.00	-29.06	-29.11	-29.17	-29.22	-29.28	-29.33	-29.39
21	29.44	29.50	29.56	29.61	29.67	29.72	29.78	29.83	29.89	29.94
22	30.00	30.06	30.11	30.17	30.22	30.28	30.33	30.39	30.44	30.50
23	30.56	30.61	30.67	30.72	30.78	30.83	30.89	30.94	31.00	31.06
24	31.11	31.17	31.22	31.28	31.33	31.39	31.44	31.50	31.56	31.61
-25	-31.67	-31.72	-31.78	-31.83	-31.89	-31.94	-32.00	-32.06	-32.11	-32.17
26	32.22	32.28	32.33	32.39	32.44	32.50	32.56	32.61	32.67	32.72
27	32.78	32.83	32.89	32.94	33.00	33.06	33.11	33.17	33.22	33.28
28	33.33	33.39	33.44	33.50	33.56	33.61	33.67	33.72	33.78	33.83
29	33.89	33.94	34.00	34.06	34.11	34.17	34.22	34.28	34.33	34.39
-30	-34.44	-34.50	-34.56	-34.61	-34.67	-34.72	-34.78	-34.83	-34.89	-34.94
31	35.00	35.06	35.11	35.17	35.22	35.28	35.33	35.39	35.44	35.50
32	35.56	35.61	35.67	35.72	35.78	35.83	35.89	35.94	36.00	36.06
33	36.11	36.17	36.22	36.28	36.33	36.39	36.44	36.50	36.56	36.61
34	36.67	36.72	36.78	36.83	36.89	36.94	37.00	37.06	37.11	37.17

continued

°F.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
-35-	-37.22	-37.28	-37.33	-37.39	-37.44	-37.50	-37.56	-37.61	-37.67	-37.72
36-	37.78	37.83	37.89	37.94	38.00	38.06	38.11	38.17	38.22	38.28
37-	38.33	38.39	38.44	38.50	38.56	38.61	38.67	38.72	38.78	38.83
38-	38.89	38.94	39.00	39.06	39.11	39.17	39.22	39.28	39.33	39.39
39-	39.44	39.50	39.56	39.61	39.67	39.72	39.78	39.83	39.89	39.94

Precipitation Amount Conversion
Inches to Centimeters

1 inch = 2.54 centimeters
1 centimeter = 0.3937 inch

Inch	Centimeter	Inch	Centimeter	Inch	Centimeter	Inch	Centimeter
0	0	0.26	0.66	0.52	1.32	0.78	1.98
0.01	0.03	0.27	0.69	0.53	1.35	0.79	2.01
0.02	0.05	0.28	0.71	0.54	1.37	0.80	2.03
0.03	0.08	0.29	0.74	0.55	1.40	0.81	2.06
0.04	0.10	0.30	0.76	0.56	1.42	0.82	2.08
0.05	0.13	0.31	0.79	0.57	1.45	0.83	2.11
0.06	0.15	0.32	0.81	0.58	1.47	0.84	2.13
0.07	0.18	0.33	0.84	0.59	1.50	0.85	2.16
0.08	0.20	0.34	0.87	0.60	1.52	0.86	2.18
0.09	0.23	0.35	0.89	0.61	1.55	0.87	2.21
0.10	0.25	0.36	0.91	0.62	1.57	0.88	2.24
0.11	0.28	0.37	0.94	0.63	1.60	0.89	2.26
0.12	0.30	0.38	0.97	0.64	1.63	0.90	2.29
0.13	0.33	0.39	0.99	0.65	1.65	0.91	2.31
0.14	0.36	0.40	1.02	0.66	1.68	0.92	2.34
0.15	0.38	0.41	1.04	0.67	1.70	0.93	2.36
0.16	0.41	0.42	1.07	0.68	1.73	0.94	2.39
0.17	0.43	0.43	1.09	0.69	1.75	0.95	2.41
0.18	0.46	0.44	1.12	0.70	1.78	0.96	2.44
0.19	0.48	0.45	1.14	0.71	1.80	0.97	2.46
0.20	0.51	0.46	1.17	0.72	1.83	0.98	2.49
0.21	0.53	0.47	1.19	0.73	1.85	0.99	2.51
0.22	0.56	0.48	1.22	0.74	1.88	1.00	2.54
0.23	0.58	0.49	1.24	0.75	1.91		
0.24	0.61	0.50	1.27	0.76	1.93		
0.25	0.64	0.51	1.30	0.77	1.96		

Height Conversion

Feet to Meters

1 foot = 0.3048006 meter
1 meter = 3.2808 feet

Feet	0	1	2	3	4	5	6	7	8	9
	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.
0	0.000	0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
	0	10	20	30	40	50	60	70	80	90
100	30.48	33.53	36.58	39.62	42.67	45.72	48.77	51.82	54.86	57.91
200	60.96	64.01	67.06	70.10	73.15	76.20	79.25	82.30	85.34	88.39
300	91.44	84.49	97.54	100.58	103.63	106.68	109.73	112.78	115.82	118.87
400	121.92	124.97	128.02	131.06	134.11	137.16	140.21	143.26	146.30	149.35
500	152.40	155.45	158.50	161.54	164.59	167.64	170.69	173.74	176.78	179.83
600	182.88	185.93	188.98	192.02	195.07	198.12	201.17	204.22	207.26	210.31
700	213.36	216.41	219.46	222.50	225.55	228.60	231.65	234.70	237.74	240.79
800	243.84	246.89	249.94	252.98	256.03	259.08	262.13	265.18	268.22	271.27
900	274.32	277.37	280.42	283.46	286.51	289.56	292.61	295.66	298.70	301.75
1000	304.80	307.85	310.90	313.94	316.99	320.04	323.09	326.14	329.18	332.23
1100	335.28	338.33	341.38	344.42	347.47	350.52	353.57	356.62	359.67	362.71
1200	365.76	368.81	371.86	374.90	377.95	381.00	384.05	387.10	390.14	393.19
1300	396.24	399.29	402.34	405.38	408.43	411.48	414.53	417.58	420.62	423.67
1400	426.72	429.77	432.82	435.86	438.91	441.96	445.01	448.06	451.10	454.15
1500	457.20	460.25	463.30	466.34	469.39	472.44	475.49	478.54	481.58	484.63
1600	487.68	490.73	493.78	496.82	499.87	502.92	505.97	509.02	512.07	515.11
1700	518.16	521.21	524.26	527.31	530.35	533.40	536.45	539.50	542.55	545.59
1800	548.64	551.69	554.74	557.79	560.83	563.88	566.93	569.98	573.03	576.07
1900	579.12	582.17	585.22	588.27	591.31	594.36	597.41	600.46	603.51	606.55
2000	609.60	612.65	615.70	618.75	621.79	624.84	627.89	630.94	633.99	637.03
2100	640.08	643.13	646.18	649.23	652.27	655.32	658.37	661.42	664.47	667.51
2200	670.56	673.61	676.66	679.71	682.75	685.80	688.85	691.90	694.95	697.99
2300	701.04	704.09	707.14	710.19	713.23	716.28	719.33	722.38	725.43	728.47
2400	731.52	734.57	737.62	740.67	743.71	746.76	749.81	752.86	755.91	758.95
2500	762.00	765.05	768.10	771.15	774.19	777.24	780.29	783.34	786.39	789.43
2600	792.48	795.53	798.58	801.63	804.67	807.72	810.77	813.82	816.87	819.91
2700	822.96	826.01	829.06	832.11	835.15	838.20	841.25	844.30	847.35	850.39
2800	853.44	856.49	859.54	862.59	865.63	868.68	871.73	874.78	877.83	880.87
2900	883.92	886.97	890.02	893.07	896.11	899.16	902.21	905.26	908.31	911.35
3000	914.40	917.45	920.50	923.55	926.59	929.64	932.69	935.74	938.79	941.83
3100	944.88	947.93	950.98	954.03	957.06	960.12	963.17	966.22	969.27	972.31
3200	975.36	978.41	981.46	984.51	987.55	990.60	993.65	996.70	999.75	1002.79
3300	1005.84	1008.89	1011.94	1014.99	1018.03	1021.08	1024.13	1027.18	1030.23	1033.27
3400	1036.32	1039.37	1042.42	1045.47	1048.51	1051.56	1054.61	1057.66	1060.71	1063.75
3500	1066.80	1069.85	1072.90	1075.95	1078.99	1082.04	1085.09	1088.14	1091.19	1094.23
3600	1097.28	1100.33	1103.38	1106.43	1109.47	1112.52	1115.57	1118.62	1121.67	1124.71
3700	1127.76	1130.81	1133.86	1136.91	1139.95	1143.00	1146.05	1149.10	1152.15	1155.19
3800	1158.24	1161.29	1161.34	1167.39	1170.43	1173.48	1176.53	1179.58	1182.63	1185.67
3900	1188.72	1191.77	1194.82	1197.87	1200.91	1203.96	1207.01	1210.06	1213.11	1216.15

continued

Feet	0	10	20	30	40	50	60	70	80	90
4000----------	1219.2	1222.3	1225.3	1228.3	1231.4	1234.4	1237.5	1240.5	1243.6	1246.6
4100----------	1249.7	1252.7	1255.8	1258.8	1261.9	1264.9	1268.0	1271.0	1274.1	1277.1
4200----------	1280.2	1283.2	1286.3	1289.3	1292.4	1295.4	1298.5	1301.5	1304.5	1307.6
4300----------	1310.6	1313.7	1316.7	1319.8	1322.8	1325.9	1328.9	1332.0	1335.0	1338.1
4400----------	1341.1	1344.2	1347.2	1350.3	1353.3	1356.4	1359.4	1362.5	1365.5	1368.6
4500----------	1371.6	1374.7	1377.7	1380.7	1383.8	1386.8	1389.9	1392.9	1396.0	1399.0
4600----------	1402.1	1405.1	1408.2	1411.2	1414.3	1417.3	1420.4	1423.4	1426.5	1429.5
4700----------	1432.6	1435.6	1438.7	1441.7	1444.8	1447.8	1450.9	1453.9	1456.9	1460.0
4800----------	1463.0	1466.1	1469.1	1472.2	1475.2	1478.3	1481.3	1484.4	1487.4	1490.5
4900----------	1493.5	1496.6	1499.6	1502.7	1505.7	1508.8	1511.8	1514.9	1517.9	1521.0
5000----------	1524.0	1527.1	1530.1	1533.1	1536.2	1539.2	1542.3	1545.3	1548.4	1551.4
5100----------	1554.5	1557.5	1560.6	1563.6	1566.7	1569.7	1572.8	1575.8	1578.9	1581.9
5200----------	1585.0	1588.0	1591.1	1594.1	1597.2	1600.2	1603.3	1606.3	1609.3	1612.4
5300----------	1615.4	1618.5	1621.5	1624.6	1627.6	1630.7	1633.7	1636.8	1639.8	1642.9
5400----------	1645.9	1649.0	1652.0	1655.1	1658.1	1661.2	1664.2	1667.3	1670.3	1673.4
5500----------	1676.4	1679.5	1682.5	1685.5	1688.6	1691.6	1694.7	1697.7	1700.8	1703.8
5600----------	1706.9	1709.9	1713.0	1716.0	1719.1	1722.1	1725.2	1728.2	1731.3	1734.3
5700----------	1737.4	1740.4	1743.5	1746.5	1749.6	1752.6	1755.7	1758.7	1761.7	1764.8
5800----------	1767.8	1770.9	1773.9	1777.0	1780.0	1783.1	1786.1	1789.2	1792.2	1795.3
5900----------	1798.3	1801.4	1804.4	1807.5	1810.5	1813.6	1816.6	1819.7	1822.7	1825.8
6000----------	1828.8	1831.9	1834.9	1837.9	1841.0	1844.0	1847.1	1850.1	1853.2	1856.2
6100----------	1859.3	1862.3	1865.4	1868.4	1871.5	1874.5	1877.6	1880.6	1883.7	1886.7
6200----------	1889.8	1892.8	1895.9	1898.9	1902.0	1905.0	1908.1	1911.1	1914.1	1917.2
6300----------	1920.2	1923.3	1926.3	1929.4	1932.4	1935.5	1938.5	1941.6	1944.6	1947.7
6400----------	1950.7	1953.8	1956.8	1959.9	1962.9	1966.0	1969.0	1972.1	1975.1	1978.2
6500----------	1981.2	1984.3	1987.3	1990.3	1993.4	1996.4	1999.5	2002.5	2005.6	2008.6
6600----------	2011.7	2014.7	2017.8	2020.8	2023.9	2026.9	2030.0	2033.0	2036.1	2039.1
6700----------	2042.2	2045.2	2048.3	2051.3	2054.4	2057.4	2060.5	2063.5	2066.5	2069.6
6800----------	2072.6	2075.7	2078.7	2081.8	2084.8	2087.9	2090.9	2094.0	2097.0	2100.1
6900----------	2103.1	2106.2	2109.2	2112.3	2115.3	2118.4	2121.4	2124.5	2127.5	2130.6
7000----------	2133.6	2136.7	2139.7	2142.7	2145.8	2148.8	2151.9	2154.9	2158.0	2161.0
7100----------	2164.1	2167.1	2170.2	2173.2	2176.3	2179.3	2182.4	2185.4	2188.5	2191.5
7200----------	2194.6	2197.6	2200.7	2203.7	2206.8	2209.8	2212.9	2215.9	2218.9	2222.0
7300----------	2225.0	2228.1	2231.1	2234.2	2237.2	2240.3	2243.3	2246.4	2249.4	2252.5
7400----------	2255.5	2258.6	2261.6	2264.7	2267.7	2270.8	2273.8	2276.9	2279.9	2283.0
7500----------	2286.0	2289.1	2292.1	2295.1	2298.2	2301.2	2304.3	2307.3	2310.4	2313.4
7600----------	2316.5	2319.5	2322.6	2325.6	2328.7	2331.7	2334.8	2337.8	2340.9	2343.9
7700----------	2347.0	2350.0	2353.1	2356.1	2359.2	2362.2	2365.3	2368.3	2371.3	2374.4
7800----------	2377.4	2380.5	2383.5	2386.6	2389.6	2392.7	2395.7	2398.8	2401.8	2404.9
7900----------	2407.9	2411.0	2414.0	2417.1	2420.1	2423.2	2426.2	2429.3	2432.3	2435.4
8000----------	2438.4	2441.5	2444.5	2447.5	2450.6	2453.6	2456.7	2459.7	2462.8	2465.8
8100----------	2468.9	2471.9	2475.0	2478.0	2481.1	2484.1	2487.2	2490.2	2493.3	2496.3
8200----------	2499.4	2502.4	2505.5	2508.5	2511.6	2514.6	2517.7	2520.7	2523.7	2526.8
8300----------	2529.8	2532.9	2535.9	2539.0	2542.0	2545.1	2548.1	2551.2	2554.2	2557.3
8400----------	2560.3	2563.4	2566.4	2569.5	2572.5	2575.6	2578.6	2581.7	2584.7	2587.8
8500----------	2590.8	2593.9	2596.9	2599.9	2603.0	2606.0	2609.1	2612.1	2615.2	2618.2
8600----------	2621.3	2624.3	2627.4	2630.4	2633.5	2636.5	2639.6	2642.6	2645.7	2648.7
8700----------	2651.8	2654.8	2657.9	2660.9	2664.0	2667.0	2670.1	2673.1	2676.1	2679.2
8800----------	2682.2	2685.3	2688.3	2691.4	2694.4	2697.5	2700.5	2703.6	2706.6	2709.7
8900----------	2712.7	2715.8	2718.8	2721.9	2724.9	2728.0	2731.0	2734.1	2737.1	2740.2
	0	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**
9000----------	2743	2774	2804	2835	2865	2896	2926	2957	2987	3018
10000----------	3048	3078	3109	3139	3170	3200	3231	3261	3292	3322
11000----------	3353	3383	3414	3444	3475	3505	3536	3566	3597	3627
12000----------	3658	3688	3719	3749	3780	3810	3840	3871	3901	3932
13000----------	3962	3993	4023	4054	4084	4115	4145	4176	4206	4237
14000----------	4267	4298	4328	4359	4389	4420	4450	4481	4511	4542

continued

Feet	0	100	200	300	400	500	600	700	800	900
15000----------	4572	4602	4633	4663	4694	4724	4755	4785	4816	4846
16000----------	4877	4907	4938	4968	4999	5029	5060	5090	5121	5151
17000----------	5182	5212	5243	5273	5304	5334	5364	5395	5425	5456
18000----------	5486	5517	5547	5578	5608	5639	5669	5700	5730	5761
19000----------	5791	5822	5852	5883	5913	5944	5974	6005	6035	6066
20000----------	6096	6126	6157	6187	6218	6248	6279	6309	6340	6370
21000----------	6401	6431	6462	6492	6523	6553	6584	6614	6645	6675
22000----------	6706	6736	6767	6797	6828	6858	6888	6919	6949	6980
23000----------	7010	7041	7071	7102	7132	7163	7193	7224	7254	7285
24000----------	7315	7346	7376	7407	7437	7468	7498	7529	7559	7590
25000----------	7620	7650	7681	7711	7742	7772	7803	7833	7864	7894
26000----------	7925	7955	7986	8016	8047	8077	8108	8138	8169	8199
27000----------	8230	8260	8291	8221	8352	8382	8412	8443	8473	8504
28000----------	8534	8565	8595	8626	8656	8687	8717	8748	8778	8809
29000----------	8839	8870	8900	8931	8961	8992	9022	9053	9083	9114
30000----------	9144	9174	9205	9235	9266	9296	9327	9357	9388	9418
31000----------	9449	9479	9510	9540	9571	9601	9632	9662	9693	9723
32000----------	9754	9784	9815	9845	9876	9906	9936	9967	9997	10028
33000----------	10058	10089	10119	10150	10180	10211	10241	10272	10302	10333
34000----------	10363	10394	10424	10455	10485	10516	10546	10577	10607	10638
35000----------	10668	10699	10729	10759	10790	10820	10851	10881	10912	10942
36000----------	10973	11003	11034	11064	11095	11125	11156	11186	11217	11247
37000----------	11278	11308	11339	11369	11400	11430	11461	11491	11521	11552
38000----------	11582	11613	11643	11674	11704	11735	11765	11796	11826	11857
39000----------	11887	11918	11948	11979	12009	12040	12070	12101	12131	12162
40000----------	12192	12223	12253	12283	12314	12344	12375	12405	12436	12466

Visibility Conversion

Statute Miles (mi) to Kilometers (km)

1 statute mile	=	5280 feet
	=	0.868976 nautical mile
	=	1.609344 kilometers
1 kilometer	=	3281 feet
	=	0.6215 statute mile
	=	0.53946 nautical mile

Statute Miles	Kilometers	Statute Miles	Kilometers
0	0	2	3.2
1/16	0.1	2 1/4	3.6
1/8	0.2	2 1/2	4.0
3/16	0.3	3	4.8
1/4	0.4	4	6.4
5/16	0.5	5	8.0
3/8	0.6	6	9.7
1/2	0.8	7	11.3
5/8	1.0	8	12.9
3/4	1.2	9	14.5
7/8	1.4	10	16.1
		11	17.7
1	1.6	12	19.3
1 1/8	1.8	13	20.9
1 1/4	2.0	14	22.5
1 3/8	2.2	15	24.1
1 1/2	2.4	20	32.2
1 5/8	2.6	25	40.2
1 3/4	2.8	30	48.3
1 7/8	3.0		

Nautical Miles to Kilometers Conversion

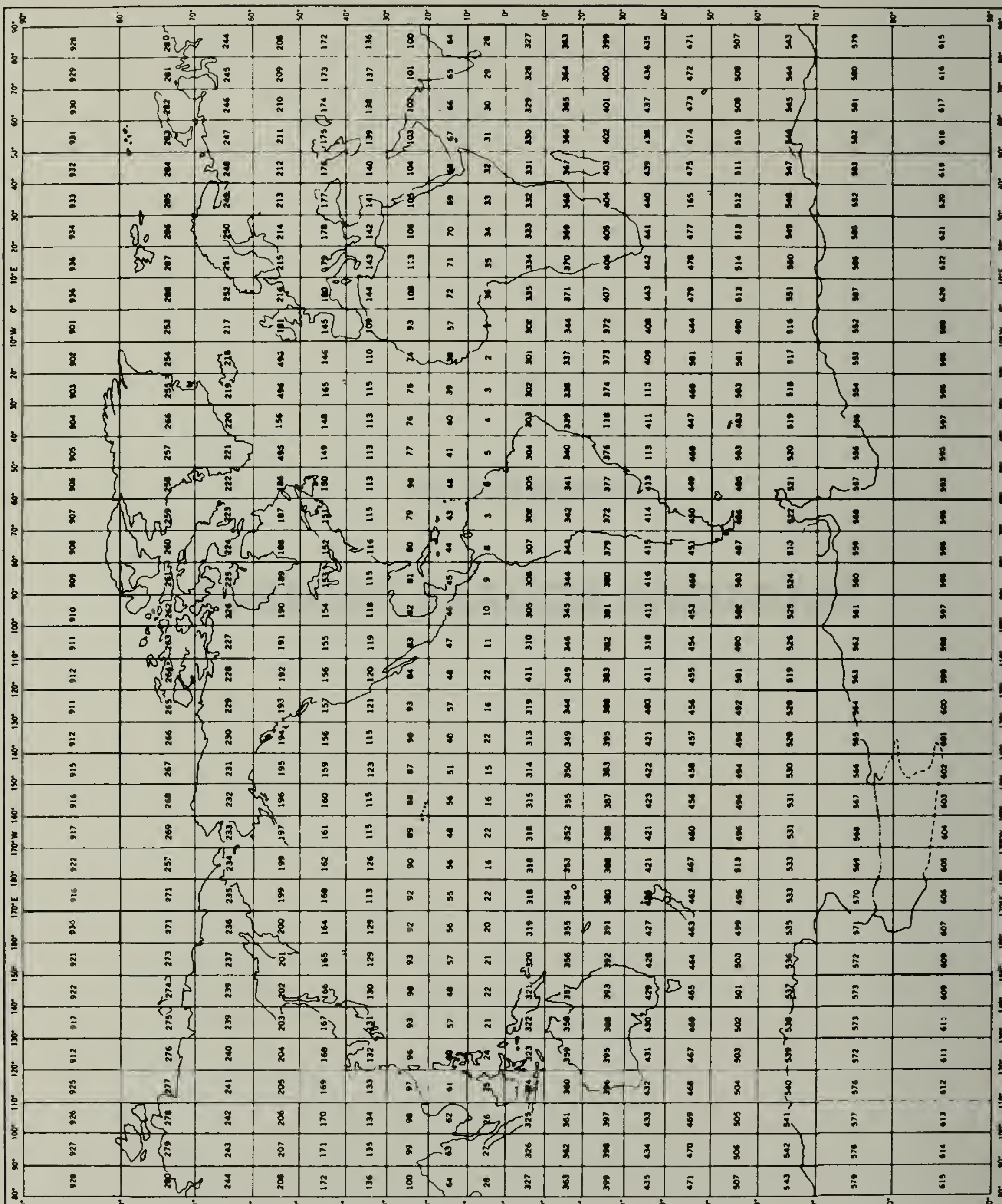
For Wind Speed and Visibility

1 nautical mile	=	6076.11549 feet
	=	1.852 kilometers
	=	1.15078 statute miles
1 kilometer	=	3281 feet
	=	0.6215 statute miles
	=	0.53946 nautical miles
1 statute mile	=	5280 feet
	=	0.8689763 nautical miles
	=	1.609344 kilometers

Nautical Miles	Kilometers	Nautical Miles	Kilometers	Nautical Miles	Kilometers
0	0	26	48.2	52	96.2
1	1.8	27	50.0	53	98.1
2	3.7	28	51.8	54	99.9
3	5.6	29	53.7	55	101.8
4	7.4	30	55.5	56	103.6
5	9.3	31	57.4	57	105.5
6	11.1	32	59.2	58	107.3
7	13.0	33	61.1	59	109.2
8	14.8	34	62.9	60	111.0
9	16.7	35	64.8	61	112.9
10	18.5	36	66.6	62	114.7
11	20.4	37	68.5	63	116.6
12	22.2	38	70.3	64	118.4
13	24.1	39	72.2	65	120.3
14	25.9	40	74.0	66	122.1
15	27.8	41	75.9	67	124.0
16	29.6	42	77.7	68	125.8
17	31.5	43	79.6	69	127.7
18	33.3	44	81.4	70	129.5
19	35.2	45	83.3	71	131.4
20	37.0	46	85.1	72	133.2
21	38.9	47	87.0	73	135.1
22	40.7	48	88.8	74	136.9
23	42.6	49	90.7	75	138.8
24	44.4	50	92.5		
25	46.3	51	94.4		

APPENDIX III

MARSDEN SQUARE NUMBER



APPENDIX IV

EXPLANATION OF WEATHER CODE NUMBERS AND SYMBOLS

C_H ...f type C_H	C Type of Cloud	W Past Weather	N Total amount all clouds	a Barometer characteristic
...or Cs clouds.	0 Ci	0 Cloud covering ½ or less of sky throughout the period.	0 No clouds.	0 Rising then falling. Now higher than, or the same as, 3 hours ago.
...ands, or hooks of Ci,	1 Cc	1 Cloud covering more than ½ of sky during part of period and covering ½ or less during part of period.	1 One-tenth or less, but not zero.	1 Rising, then steady; or rising, then rising more slowly. Now higher than 3 hours ago.
...atches or twisted ...not increasing; or Ci ...attlements or resembl- ...ufts.	2 Cs	2 Cloud covering more than ½ of sky throughout the period.	2 Two- or three-tenths.	2 Rising (steadily or unsteadily). Now higher than 3 hours ago.
...-shaped, derived from ...h Cb.	3 Ac	3 Sandstorm, or duststorm, or drifting or blowing snow.	3 Four-tenths.	3 Falling or steady, then rising; or rising then rising more rapidly. Now higher than 3 hours ago.
...ed and/or filaments, ...the sky and generally ...as a whole.	4 As	4 Fog, or thick haze.	4 Five-tenths.	4 Steady. Same as 3 hours ago.
...verging bands, and ...t increasing and grow- ...hole; the continuous ...g 45° above horizon.	5 Ns	5 Drizzle.	5 Six-tenths.	5 Falling, then rising. Now lower than, or the same as, 3 hours ago.
...verging bands, and Cs ...creasing and growing ...; the continuous veil ...e horizon but sky not	6 Sc	6 Rain.	6 Seven-or eight-tenths.	6 Falling, then steady; or falling, then falling more slowly. Now lower than 3 hours ago.
...mpletely covering the	7 St	7 Snow, or rain and snow mixed, or ice pellets (sleet).	7 Nine-tenths or more, but not ten-tenths.	7 Falling (steadily or unsteadily). Now lower than 3 hours ago.
...ing and not completely	8 Cu	8 Shower(s).	8 Ten-tenths.	8 Steady or rising, then falling; or falling, then falling more rapidly. Now lower than 3 hours ago.
...c accompanied by Ci ...Cc is the predominant	9 Cb	9 Thunderstorm, with or without precipitation.	9 Sky obscured, or cloud amount cannot be estimated.	9 Indicator figure. Regionally agreed elements and NOT "pp" are reported by the next two code figures.

§ The symbol is not plotted for "ww" when "00" is reported. When "01, 02, or 03" is reported for "ww", the symbol is plotted on the station circle.
† Refers to "hail" only. †† Refers to "Soft hail", "small hail", and "hail".

ww PRESENT WEATHER

Code	Description
00	Cloud development NOT observed or NOT observable during past hour.§
01	Clouds generally dissolving or becoming less developed during past hour.§
02	State of sky on the whole unchanged during past hour.§
03	Clouds generally forming or developing during past hour.§
04	Visibility reduced by smoke.
05	Haze.
06	Widespread dust in suspension in the air, NOT raised by wind, at time of observation.
07	Dust or sand raised by wind, at time of ob.
08	Well developed dust devil(s) within past hour.
09	Duststorm or sandstorm within sight of or at station during past hour.
10	Light fog.
11	Patches of shallow fog at station, NOT deeper than 6 feet on land.
12	More or less continuous shallow fog at station, NOT deeper than 6 feet on land.
13	Lightning visible, no thunder heard.
14	Precipitation within sight, but NOT reaching the ground.
15	Precipitation within sight, reaching the ground, but distant from station.
16	Precipitation within sight, reaching the ground, near to but NOT at station.
17	Thunder heard, but no precipitation at the station.
18	Squall(s) within sight during past hour.
19	Funnel cloud(s) within sight during past hour.
20	Drizzle (NOT freezing and NOT falling as showers) during past hour, but NOT at time of ob.
21	Rain (NOT freezing and NOT falling as showers) during past hour, but NOT at time of ob.
22	Snow (NOT falling as showers) during past hour, but NOT at time of observation.
23	Rain and snow (NOT falling as showers) during past hour, but NOT at time of observation.
24	Freezing drizzle or freezing rain (NOT falling as showers) during past hour, but NOT at time of observation.
25	Showers of rain during past hour, but NOT at time of observation.
26	Showers of snow, or of rain and snow, during past hour, but NOT at time of observation.
27	Showers of hail, or of hail and rain, during past hour, but NOT at time of observation.
28	Fog during past hour, but NOT at time of observation.
29	Thunderstorm (with or without precipitation) during past hour, but NOT at time of ob.
30	Slight or moderate duststorm or sandstorm, has decreased during past hour.
31	Slight or moderate duststorm or sandstorm, no appreciable change during past hour.
32	Slight or moderate duststorm or sandstorm, has increased during past hour.
33	Severe duststorm or sandstorm, has decreased during past hour.
34	Severe duststorm or sandstorm, no appreciable change during past hour.
35	Severe duststorm or sandstorm, has increased during past hour.
36	Slight or moderate drifting snow, generally low.
37	Heavy drifting snow, generally low.
38	Slight or moderate drifting snow, generally high.
39	Heavy drifting snow, generally high.
40	Fog at distance at time of observation, but NOT at station during past hour.
41	Fog in patches.
42	Fog, sky discernible, has become thinner during past hour.
43	Fog, sky NOT discernible, has become thinner during past hour.
44	Fog, sky discernible, no appreciable change during past hour.
45	Fog, sky NOT discernible, no appreciable change during past hour.
46	Fog, sky discernible, has begun or become thicker during past hour.
47	Fog, sky NOT discernible, has begun or become thicker during past hour.
48	Fog, depositing rime, sky discernible.
49	Fog, depositing rime, sky NOT discernible.
50	Intermittent drizzle (NOT freezing) slight at time of observation.
51	Continuous drizzle (NOT freezing) slight at time of observation.
52	Intermittent drizzle (NOT freezing) moderate at time of observation.
53	Continuous drizzle (NOT freezing), moderate at time of observation.
54	Intermittent drizzle (NOT freezing), thick at time of observation.
55	Continuous drizzle (NOT freezing), thick at time of observation.
56	Slight freezing drizzle.
57	Moderate or thick freezing drizzle.
58	Drizzle and rain, slight.
59	Drizzle and rain, moderate or heavy.
60	Intermittent rain (NOT freezing), slight at time of observation.
61	Continuous rain (NOT freezing), slight at time of observation.
62	Intermittent rain (NOT freezing), moderate at time of observation.
63	Continuous rain (NOT freezing), moderate at time of observation.
64	Intermittent rain (NOT freezing), heavy at time of observation.
65	Continuous rain (NOT freezing), heavy at time of observation.
66	Slight freezing rain.
67	Moderate or heavy freezing rain.
68	Rain or drizzle and snow, slight.
69	Rain or drizzle and snow, moderate or heavy.
70	Intermittent fall of snow flakes, slight at time of observation.
71	Continuous fall of snow flakes, slight at time of observation.
72	Intermittent fall of snow flakes, moderate at time of observation.
73	Continuous fall of snow flakes, moderate at time of observation.
74	Intermittent fall of snow flakes, heavy at time of observation.
75	Continuous fall of snow flakes, heavy at time of observation.
76	Ice needles (with or without fog).
77	Granular snow (with or without fog).
78	Isolated starlike snow crystals (with or without fog).
79	Ice pellets (sleet, U. S. definition).
80	Slight rain shower(s).
81	Moderate or heavy rain shower(s).
82	Violent rain showers(s).
83	Slight shower(s) of rain and snow mixed.
84	Moderate or heavy shower(s) of rain and snow mixed.
85	Slight snow shower(s).
86	Moderate or heavy snow shower(s).
87	Slight shower(s) of soft or small hail with or without rain or rain and snow mixed.
88	Moderate or heavy shower(s) of soft or small hail with or without rain or rain and snow mixed.
89	Slight shower(s) of hail†, with or without rain or rain and snow mixed, not associated with thunder.
90	Moderate or heavy shower(s) of hail††, with or without rain or rain and snow mixed, not associated with thunder.
91	Slight rain at time of observation; thunderstorm during past hour, but NOT at time of observation.
92	Moderate or heavy rain at time of observation; thunderstorm during past hour, but NOT at time of observation.
93	Slight snow or rain and snow mixed or hail† at time of observation; thunderstorm during past hour, but NOT at time of observation.
94	Moderate or heavy snow, or rain and snow mixed or hail† at time of observation; thunderstorm during past hour, but NOT at time of observation.
95	Slight or moderate thunderstorm without hail†, but with rain and/or snow at time of observation.
96	Slight or moderate thunderstorm, with hail† at time of observation.
97	Heavy thunderstorm, without hail†, but with rain and/or snow at time of observation.
98	Thunderstorm combined with dust storm or sandstorm at time of observation.
99	Heavy thunderstorm with hail† at time of observation.

C_L Clouds of type C_L / C_M Clouds of type C_M / C_H Cloud of type C_H

Code	C_L Clouds of type C_L	C_M Clouds of type C_M	C_H Cloud of type C_H
0	No Sc, St, Cu, or Cb clouds.	No Ac, As or Ns clouds.	No Ci, Cc, or Cs clouds.
1	Ragged Cu, other than bad weather, or Cu with little vertical development and seemingly flattened, or both.	As, the greatest part of which is semitransparent through which the sun or moon may be faintly visible as through ground glass.	Filaments, strands, or hooks of Ci, not increasing.
2	Cu of considerable development, generally towering, with or without other Cu or Sc; bases all at same level.	As, the greatest part of which is sufficiently dense to hide the sun or moon, or Ns.	Dense Ci in patches or twisted sheaves, usually not increasing; or Ci with towers or battlements or resembling cumuliform tufts.
3	Cb with tops lacking clear-cut outlines, but are clearly not fibrous, cirriform, or anvil shaped; Cu, Sc, or St may be present.	Ac (most of layer is semitransparent) other than crenelated or in cumuliform tufts; cloud elements change but slowly with all bases at a single level.	Ci, often anvil-shaped, derived from or associated with Cb.
4	Sc formed by spreading out of Cu; Cu may be present also.	Patches of semitransparent Ac which are at one or more levels; cloud elements are continuously changing.	Ci, hook-shaped and/or filaments, spreading over the sky and generally becoming denser as a whole.
5	Sc not formed by spreading out of Cu.	Semitransparent Ac in bands or Ac in one more or less continuous layer gradually spreading over sky and usually thickening as a whole; the layer may be opaque or a double sheet.	Ci, often in converging bands, and Cs or Cs alone but increasing and growing denser as a whole; the continuous veil not exceeding 45° above horizon.
6	St in a more or less continuous layer and/or in ragged shreds, but no Fs of bad weather.	Ac formed by the spreading out of Cu.	Ci, often in converging bands, and Cs or Cs alone but increasing and growing denser as a whole; the continuous veil exceeds 45° above horizon but sky not totally covered.
7	Fs and/or Fc of bad weather (scud) usually under As and Ns.	Double-layered Ac or an opaque layer of Ac, not increasing over the sky; or Ac coexisting with As or Ns or with both.	Veil of Cs completely covering the sky.
8	Cu and Sc (not formed by spreading out of Cu); base of Cu at a different level than base of Sc.	Ac with sprouts in the form of small towers or battlements or Ac having the appearance of cumuliform tufts.	Cs not increasing and not completely covering the sky.
9	Cb having a clearly fibrous (cirriform) top, often anvil-shaped, with or without Cu, Sc, St, or scud.	Ac, generally at several layers in a chaotic sky; dense Cirrus is usually present.	Cc alone or Cc accompanied by Ci and/or Cs, but Cc is the predominant cirriform cloud.

C Type of Cloud / W Past Weather / N Total amount all clouds / a Barometer characteristic

Code	C Type of Cloud	W Past Weather	N Total amount all clouds	a Barometer characteristic
0	Ci	Cloud covering ½ or less of sky throughout the period.	No clouds.	Rising then falling. Now higher than, or the same as, 3 hours ago.
1	Cc	Cloud covering more than ½ of sky during part of period and covering ½ or less during part of period.	One-tenth or less, but not zero.	Rising, then steady; or rising, then rising more slowly. Now higher than 3 hours ago.
2	Cs	Cloud covering more than ½ of sky throughout the period.	Two- or three-tenths.	Rising (steadily or unsteadily). Now higher than 3 hours ago.
3	Ac	Sandstorm, or duststorm, or drifting or blowing snow.	Four-tenths.	Falling or steady, then rising; or rising then rising more rapidly. Now higher than 3 hours ago.
4	As	Fog, or thick haze.	Five-tenths.	Steady. Same as 3 hours ago.
5	Ns	Drizzle.	Six-tenths.	Falling, then rising. Now lower than, or the same as, 3 hours ago.
6	Sc	Rain.	Seven-or eight-tenths	Falling, then steady; or falling, then falling more slowly. Now lower than 3 hours ago.
7	St	Snow, or rain and snow mixed, or ice pellets (sleet).	Nine-tenths or more, but not ten-tenths.	Falling (steadily or unsteadily). Now lower than 3 hours ago.
8	Cu	Shower(s).	Ten-tenths.	Steady or rising, then falling; or falling, then falling more rapidly. Now lower than 3 hours ago.
9	Cb	Thunderstorm, with or without precipitation.	Sky obscured, or cloud amount cannot be estimated.	Indicator figure. Regionally agreed elements and NOT "pp" are reported by the next two code figures.

APPENDIX V

FEDERAL METEOROLOGICAL FORM 1-10
SURFACE WEATHER OBSERVATIONS
(CNOC 3140/7)

Hrs Hrs	MAG TO TRUE + Deg − Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

REMARKS AND SUPPLEMENTARY CODED DATA RED ORDER OF ENTRY: RVR, SFC based absc phenomena, remarks elaborating on preceding coded data 3- and 6- hourly additive data, radiosonde data, runway conditions, weather modification (13)	STATION PRESSURE (inches) (17)	TOTAL SKY COVER (21)	OBS INIT (15)

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

CNOC 3140/7 REV.(10-79) 0108-LF-031-4037

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10) (ABRIDGED FORM FOR MILITARY USE)	LATITUDE	LONGITUDE	STATION ELEVATION (H_p) FEET (MSL)	TIME CONVERSION LST to GMT + Hrs − Hrs	MAG TO TRUE + Deg − Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

TYPE (1)	TIME (GMT) (2)	SKY CONDITION (3)	PVLG VSBY (miles) (4)	WEATHER AND OBSTNS TO VISION (5)	SEA LEVEL PRES (mb) (6)	TEMP (^{0}F) (7)	DEW-POINT (^{0}F) (8)	WIND DRCTN (true) (9)	WIND SPEED (knots) (10)	WIND CHARACTER (knots) (11)	ALSTG (inches) (12)	REMARKS AND SUPPLEMENTARY CODED DATA DESIRED ORDER OF ENTRY: RVR, SFC based absc phenomena, remarks elaborating on preceding coded data 3- and 6-hourly additive data, radiosonde data, runway conditions, weather modification (13)	STATION PRESSURE (inches) (17)	TOTAL SKY COVER (21)	OBS INIT (15)

SYNOPTIC DATA TIME (GMT) (41) Mid (LST) to:	TIME (LST) (42) Mid to:	NO. (43)	PRECIP (water equiv) (44)	SNOW FALL (45)	SNOW DEPTH (46)
		(1)			
		(2)			
		(3)			
		(4)			
Mid (LST)	Mid (LST)				

STATION PRESSURE COMPUTATION					
TIME (GMT) (59)					
ATT THERM (60)					
OBSRVD BAR (61)					
TOTAL CORR (62)					
STA PRESS (63)					
BAROGRAPH (64)					
BARR CORR (65)					

SUMMARY OF THE DAY

24-HR MAX TEMP (°F) (66)	24-HR MIN TEMP (°F) (67)

PRECIP (water equiv) (68)	SNOW FALL (69)	SNOW DEPTH (70)

PEAK WIND

SPEED (knots) (71)	DRCTN (true) (72)	TIME (GMT) (73)

ACTIVE RNWY AND EQUIP CHANGE

TIME (GMT)	RNWY NO.	TIME (GMT)	RNWY NO.

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

APPENDIX VI

SURFACE WEATHER OBSERVATIONS (SHIP) FORM (CNOC 3140/8)

	DATE	QUARTERMASTER	
		AEROGRAPHER'S MATE	

CODED DATA phenomena, remarks elaborating	OBS INIT (15)	STATION PRESSURE *(inches)* (17)	SKY COVER TOTAL (21)	POSITION QLLlll (A)	COURSE (B)	SPD (C)	SEA WATER ($\frac{1}{10}$ °C) (D)	SEA WAVES PERIOD HEIGHT (E)	SWELL WAVES DIRECTION PERIOD HEIGHT (F)

SECTION 2

//	222 $D_s v_s$	0 $S_n T_w T_w T_w$	2 $P_w P_w H_w H_w$	3d_{w1} d_{w1}	d_{w2} d_{w2}	4P_{w1} P_{w1} H_{w1} H_{w1}	5P_{w2} P_{w2} H_{w2} H_{w2}	6 $I_s E_s E_s R_s$	ICE	$C_i S_i b_i D_i z_i$
//	222	0	2	3		4	5	6	ICE	
//	222	0	2	3		4	5	6	ICE	
//	222	0	2	3		4	5	6	ICE	
//	222	0	2	3		4	5	6	ICE	
//	222	0	2	3		4	5	6	ICE	
//	222	0	2	3		4	5	6	ICE	
//	222	0	2	3		4	5	6	ICE	
//	222	0	2	3		4	5	6	ICE	

CNOC-3140/8 (REV 1/82) 0108-LF-031-4043

PART I SURFACE WEATHER OBSERVATIONS (SHIP/AVIATION)	U.S.S.	DATE	QUARTERMASTER / AEROGRAPHER'S MATE

TYPE (1)	TIME (GMT) (2)	SKY AND CEILING *(HUNDREDS OF FEET)* (3)	VISIBILITY *(NAUT-MILES)* (4)	WX & OBSTRN TO VIS (5)	SEA LEVEL PRES *(MB)* (6)	TEMP ($\frac{1}{10}$ °F) (7)	DEW PT. (°F) (8)	WIND DRCTN (9)	WIND SPEED *(kts)* (10)	WIND CHARACTER AND SHIFTS (11)	ALSTG *(inches)* (12)	REMARKS AND SUPPLEMENTARY CODED DATA DESIRED ORDER OF ENTRY: SFC based on obsc phenomena, remarks elaborating on preceding coded data (13)	OBS INIT (15)	STATION PRESSURE *(inches)* (17)	SKY COVER TOTAL (21)	POSITION QLLIII (A)	COURSE (B)	SPD (C)	SEA WATER ($\frac{1}{10}$ °C) (D)	SEA WAVES PERIOD HEIGHT (E)	SWELL WAVES DIRECTION PERIOD HEIGHT (F)

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

PART II SYNOPTIC CODE MESSAGE FORMAT

SECTION 0					SECTION 1										SECTION 2									
BBXX	DDDD	YYGGI$_w$	99 L$_a$L$_a$L$_a$	Q$_c$L$_o$L$_o$L$_o$L$_o$	i$_r$i$_x$hvv	Nddff	1 S$_n$TTT	2 S$_n$T$_d$T$_d$T$_d$	4 PPPP	5 aPPP	7 wwW$_1$W$_2$	8 N$_h$C$_L$C$_M$C$_H$	9hh	//	222 D$_s$v$_s$	0 S$_n$T$_w$T$_w$T$_w$	2 P$_w$P$_w$H$_w$H$_w$	3d$_{w1}$d$_{w1}$	d$_{w2}$d$_{w2}$	4P$_{w1}$P$_{w1}$H$_{w1}$H$_{w1}$	5P$_{w2}$P$_{w2}$H$_{w2}$H$_{w2}$	6 I$_s$E$_s$E$_s$R$_s$	ICE	C$_i$S$_i$b$_i$D$_i$z$_i$
BBXX	TRANSMIT	00	99		4		1	2	4	5	7	8	9	//	222	0	2	3		4	5	6	ICE	
BBXX	BUT	03	99		4		1	2	4	5	7	8	9	//	222	0	2	3		4	5	6	ICE	
BBXX	DO NOT	06	99		4		1	2	4	5	7	8	9	//	222	0	2	3		4	5	6	ICE	
BBXX	ENCODE	09	99		4		1	2	4	5	7	8	9	//	222	0	2	3		4	5	6	ICE	
BBXX	ON THIS	12	99		4		1	2	4	5	7	8	9	//	222	0	2	3		4	5	6	ICE	
BBXX	FORM	15	99		4		1	2	4	5	7	8	9	//	222	0	2	3		4	5	6	ICE	
BBXX		18	99		1		1	2	4	5	7	8	9	//	222	0	1	3		4	5	6	ICE	
BBXX		21	99		4		4	2	4	5	7	8	9	//	222	0	2	3		4	5	6	ICE	

OPTIONAL: ENCODE ONLY IF SIGNIFICANT, UPON REQUEST, IF MODLOCKED OR ANCHORED.

☆GPO - 1981 - 774-257

APPENDIX VII

SURFACE WEATHER OBSERVATIONS (METAR) FORM (CNOC 3140/11)

Hrs Hrs	MAG TO TRUE + Deg - Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

ALSTG (inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (*All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating precoding data, coded additive data group (if specified) radio-sonde data, runway conditions, weather modification.*) (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

CNOC 3140/11 REV. (1–80) 0108–LF–031–4055

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (MF1-10)
METAR (ABRIDGED FORM FOR MILITARY USE)

LATITUDE	LONGITUDE	STATION ELEVATION (H_p) FEET (MSL)	TIME CONVERSION LST to GMT) + Hrs − Hrs	MAG TO TRUE + Deg − Deg	DAY (LST)	MONTH	YEAR	STATION AND STATE OR COUNTRY

TYPE (1)	TIME (GMT) (2)	WIND			VISIBILITY				WEATHER AND OBSTRUCTIONS TO VISION		SKY CONDITION (3)	TEMP (°C) (7)	DEW-POINT (°C) (8)	ALSTG (inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (All times GMT. DESIRED ORDER OF ENTRY: Ceiling height, other remarks elaborating precoding data, coded additive data group (if specified) radiosonde data, runway conditions, weather modification.) (13)	STATION PRESSURE (inches) (17)	SEA LEVEL PRES (mb) (6)	TOTAL SKY COVER (21)	OBS INIT (15)
		DRCTN (true) (9)	SPEED (knots) (10)	MAX WIND (knots) (11)	PREVAILING		RUNWAY VISUAL RANGE												
					MILES (4A)	METERS (4B)	LOCAL (feet or miles) (4C)	LONG-LINE (meters) (4D)	LOCAL (5A)	LONG-LINE (5B)									

SYNOPTIC DATA					
TIME (GMT) (41) Mid (LST) to:	TIME (LST) (42) Mid to:	NO. (43)	PRECIP (water equiv) (44)	SNOW FALL (45)	SNOW DEPTH (46)
		(1)			
		(2)			
		(3)			
		(4)			
Mid (LST)	Mid (LST)				

STATION PRESSURE COMPUTATION				
TIME (GMT) (59)				
ATT THERM (60)				
OBSRVD BAR (61)				
TOTAL CORR (62)				
STA PRESS (63)				
BAROGRAPH (64)				
BARR CORR (65)				

SUMMARY OF THE DAY		
24-HR MAX TEMP (°F) (66)	24-HR MIN TEMP (°F) (67)	
PRECIP (water equiv) (68)	SNOW FALL (69)	SNOW DEPTH (70)
PEAK WIND		
SPEED (knots) (71)	DRCTN (true) (72)	TIME (GMT) (73)

ACTIVE RNWY AND EQUIP CHANGE			
TIME (GMT)	RNWY NO.	TIME (GMT)	RNWY NO.

REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA (90)

30112101044177–011
FLD00B00011

APPENDIX VIII

WIND WAVE/WIND SPEED TABLE

WIND WAVE/WIND SPEED TABLE

WIND SPEED		SEAMAN'S TERM	WORLD METEORO-LOGICAL ORGANI-ZATION (1964)	ESTIMATING WIND SPEED		WORLD METEOROLOGICAL ORGANIZATION		
KNOTS	KM PER HOUR			EFFECTS OBSERVED AT SEA	EFFECTS OBSERVED ON LAND	TERM	CODE	HEIGHT OF WAVES IN FEET
under 1	under 1	Calm	Calm	Sea like mirror.	Calm; smoke rises vertically.	Calm, glassy	0	0
1-3	1-5	Light air	Light air	Ripples with appearance of scales; no foam crests.	Smoke drift indicates wind direction; vanes do not move.			
4-6	6-11	Light breeze	Light breeze	Small wavelets; crests of glassy appearance, not breaking.	Wind felt on face; leaves rustle; vanes begin to move.	Calm, rippled	1	0 - 1/3
7-10	12-19	Gentle breeze	Gentle breeze	Large wavelets; crests begin to break; scattered whitecaps.	Leaves, small twigs in constant motion; light flags extended.	Smooth, wavelets	2	1/3 - 1 2/3
11-16	20-28	Moderate breeze	Moderate breeze	Small waves, becoming longer; numerous whitecaps.	Dust, leaves, and loose paper raised up; small branches move.	Slight	3	2 - 4
17-21	29-38	Fresh breeze	Fresh breeze	Moderate waves, taking longer form; many whitecaps; some spray.	Small trees in leaf begin to sway.	Moderate	4	4 - 8
22-27	39-49	Strong breeze	Strong breeze	Larger waves forming; whitecaps everywhere; more spray.	Larger branches of trees in motion; whistling heard in wires.	Rough	5	8 - 13
28-33	50-61	Moderate gale	Near gale	Sea heaps up; white foam from breaking waves begins to be blown in streaks.	Whole trees in motion; resistance felt in walking against wind.	Very rough	6	13 - 20
34-40	62-74	Fresh gale	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift; foam is blown in well-marked streaks.	Twigs and small branches broken off trees; progress generally impeded.			
41-47	75-88	Strong gale	Strong gale	High waves; sea begins to roll; dense streaks of foam; spray may reduce visibility.	Slight structural damage occurs; slate blown from roofs.			
48-55	89-102	Whole gale	Storm	Very high waves with overhanging crests; sea takes white appearance as foam is blown in very dense streaks; rolling is heavy and visibility reduced.	Seldom experienced on land; trees broken or uprooted; considerable structural damage occurs.	High	7	20 - 30
56-63	103-117	Storm	Violent storm	Exceptionally high waves; sea covered with white foam patches; visibility still more reduced.	Very rarely experienced on land; usually accompanied by widespread damage.	Very high	8	30 - 45
64-71 72-80 81-89 90-99 100-108 109-118	118-133 134-149 150-166 167-183 184-201 202-220	Hurricane	Hurricane	Air filled with foam; sea completely white with driving spray; visibility greatly reduced.		Phenomenal	9	over 45

APPENDIX IX

AERIAL METEOROLOGICAL RECONNAISSANCE REPORTING CODE (RECCO CODE OPNAV 3140-2)

istance to the center of the
than 95 nautical miles, 100
rom the distance and the tens
mainder is reported for "S_r"
d to the value normally report-
When a line of echoes is
is the distance to the mid-
e.

solid is used when the indi-
are not distinctly and widely
de figures 1, 2, 5, and 6 are
circular areas of echoes.

Intermediate Reports
OPTIONAL)

intermediate observations may
een complete flight level obs-
e intermediate data are report-
complete flight level message
e coded groups (i.e., Section
age immediately following the
up of the complete flight level
n 3 may be attached at the end
on 2 or Section 1, as appro-

tion 3 is OPTIONAL. If this
rted, all of the data groups
hrough mjHHH) shall be always
message for each intermedi-
n being reported with appro-
indicators being used for
for which datum is not avail-
e ($4L_aL_aL_oL_o$) group. The self-
roup may be included or omit-
l.

te data groups are extracted
ete flight level form as
9 $GGggi_u$ ddfff TTT_uT_uw
$_aL_oL_o$) $GGggi_u$ ddfff .....

se indicated it shall be as-
traight-line constant-altitude
made between the position of
ed complete flight level obs-
e present one. Any inter-
ations reported in the present
level report shall be assum-
n made on this flight patch.

of the flight has been alt-
de and longitude of the turn-
be reported by the group
The group ($4L_aL_aL_oL_o$)
ed in the Intermediate
n of the message, as appropri-
ct to time.

of the flight is altered be-
consecutive complete flight
ons, intermediate observa-
be reported between those
l reporting positions.

e Remarks

remarks may be added at the
sage to supplement the coded
ly additional information of

57. Vertical ascent or descent. WMO code form FM 35.C (TEMP) shall be used to report sounding data obtained by means of either a vertical ascent or descent.

a. If the sounding data are added to the flight level report, they shall be added to Section 2 of RECCO and identified by the indicator group 17171. In this instance the groups M_iM_i and (II)iii shall be omitted from FM 35.C and the group $GGh_1h_1h_1$ shall become $00h_1h_1h_1h_1$. The form being ..... $8w_ea_ec_el_e$ 17171 $00h_1h_1h_1$ ($T_1T_1T_{d1}T_{d1}T_{x1}$) ($0d_1d_1f_1f_1$) $P_2P_2h_2h_2h_2$ ..... etc.

In this instance the time and position of the ascent or descent shall be given in groups $GGggi_u$ $YQL_aL_aL_a$ $L_oL_oL_oBf_c'$ of the flight level report.

b. When the data obtained by means of a vertical ascent or descent are sent as a separate report, the first four groups of Section 1 of RECCO shall be followed by FM 35.C as follows: 9xxx9 $GGggi_u$ $YQL_aL_aL_a$ $L_oL_oL_oBf_c'$ 17171 ..... etc.

58. Dropsonde. Sounding data obtained from a drop-sonde released from the aircraft shall be reported by means of WMO code form FM 36.C (TEMP SHIP). The drop-sonde data may be added either to the flight level report or sent as a separate report.

a. When the drop-sonde data are added to Section 2 of RECCO the indicator group 71717 precedes the coded sounding data (FM 36.C). In this instance two minor alterations are made in FM 36.C, the M_iM_i group is omitted from the report and GG is reported to the nearest quarter hour. The nearest quarter of an hour is indicated by adding 25, 50 or 75 to the actual number of hours.

When the minute lies between 52 1/2 and 07 1/2 minutes, nothing is added to the hour; e.g., times between 0152 1/2 to 0207 1/2 are coded 02. When the minute lies between 07 1/2 and 22 1/2 minutes, 25 is added to the hour; e.g., times between 0307 1/2 to 0322 1/2 are coded 28. When the minute lies between 22 1/2 and 37 1/2 minutes 50 is added to the hour; e.g., times between 1122 1/2 to 1137 1/2 are coded 61. When the minute lies between 37 1/2 to 52 1/2 minutes 75 is added to the hour; e.g., times between 2037 1/2 to 2052 1/2 are coded 95.

b. When the drop-sonde data are sent as a separate report, the TEMP SHIP form of message (FM 36.C) is preceded by the key groups 9xxx9 and 71717.

c. The location and time (to the nearest quarter hour) at which the drop-sonde was ejected from the aircraft shall be given in the $YQL_aL_aL_a$ and $L_oL_oL_oGG$ groups of TEMP SHIP (FM 36.C).

rting Code)

...pe Reported by C	...op of Cloud Type Reported by C	Cloud Type	Altitude of Base of Cloud Type Reported by C	Altitude of Top of Cloud Type Reported by C	Group Indicator	Direction of Surface Wind	Wind Speed ...	...
	:	hh	HH	4	dd	ff	5
	3	14					
	3 – 25			26	27	28	2

1 8 - 4 8
s thereof
8 below
8 below
than 4 8 below

ime
ime
ime
ent flight

0 Spot wind
1 Winds average
2 Winds average
3 Winds average
4 Winds average
5 Winds average
6 Winds average
7 Winds average
8 Winds average
9 Winds average

OPNAV FORM 3140-2 (Rev. 1-64)
(Effective January 1, 1964)

RECCO CODE

(Aerial Meteorological Reconnaissance Reporting Code)

DATE ____________ TYPE A/C ____________
ORGANIZATION ____________ OBSERVER ____________

Section 1 — MANDATORY

Symbol	Element	See Table	See Note
9 xxx 9	Group	1	8
GGgg	Time (GCT) of Observation (hours and minutes)		9
i_u	Humidity Indicator	2	
Y	Day of Week	3	9
Q	Octant of Globe	4	
$L_a L_a L_a$	Latitude (In tens, units, and tenths of degrees)		10
$L_o L_o L_o$	Longitude (In tens, units, and tenths of degrees)		10
B	Turbulence	5	11
f'_c	Flight Conditions	6	12
hhh	True Altitude of Aircraft (100s of ft. or decameters above m. s. l.)		13
d_t	Type of Wind at Flight Altitude	7	14
d_a	Reliability of Wind at Flight Altitude	8	15
dd	Wind Direction at Altitude "hhh" (10s of degrees true)		15
fff	Wind Speed at Altitude "hhh" (knots)		15
TT	Temperature (In Whole Degrees Celsius)		16
$T_d T_d$	Dew Point (In Whole Degrees Celsius)		17
w	Present Weather	9	18
m	Remarks on Present Weather	10	19
j	Index pertaining to HHH	11	
HHH	Altitude and Other Data		

Section 2 — OPTIONAL

Symbol	Element	See Table	See Note
1	Group Indicator		20
k_n	Total Number of Cloud Layers Reported		21
$N_1 N_2 N_3$	Cloud Amount (1st. layer), Cloud Amount (2nd. layer), Cloud Amount (3rd. layer) — Ascending Order	12	22
C	Cloud Type	13	23–25
hh	Altitude of Base of Cloud Type Reported by C	14	23–25
HH	Altitude of Top of Cloud Type Reported by C	14	23–25
C	Cloud Type	13	23–25
hh	Altitude of Base of Cloud Type Reported by C	14	23–25
HH	Altitude of Top of Cloud Type Reported by C	14	23–25
C	Cloud Type	13	23–25
hh	Altitude of Base of Cloud Type Reported by C	14	23–25
HH	Altitude of Top of Cloud Type Reported by C	14	23–25
4	Group Indicator		26
dd	Direction of Surface Wind (10s of degrees true)		27
ff	Wind Speed at Surface (knots)		28
5	Group Indicator		26
D	Direction of Surface Wind	15	29
F	Force of Surface Wind	16	30
S	State of Sea	17	
D_K	Direction of Swell	15	31
6	Group Indicator		32
W_s	Significant Changes in Weather	18	33
S_s	Distance of Occurrence of Ws	19	34
W_c	Weather Off Course	20	35
D_w	Bearing (true) of Weather Off Course	15	36
7	Group Indicator		37
I_r	Rate of Icing	21	38
I_t	Type of Icing and contrails	22	39
S_b	Distance to Beginning of Icing	19	40
S_e	Distance to Ending of Icing	19	41
7	Group Indicator		37
$h_i h_i$	Altitude of Base of Icing	14	42
$H_i H_i$	Altitude of Top of Icing	14	43
8	Group Indicator		44
$d_r d_r$	Bearing of Echo Center from Aircraft (10s of degrees, true)		45
S_r	Distance to Echo Center (10s of naut. mi.)		46
O_e	Orientation of Ellipse	23	
8	Group Indicator		44
w_e	Ellipse Width or Echo Diameter (10s of naut. mi.)		
a_e	Length of Major Axis (10s of naut. mi.)		
c_e	Character of Echo	24	47
i_e	Intensity of Echo	25	
	Plain Language Remarks		54 – 55

Sounding Data ....

....

....

TABLE 1: 9xxx9

Code	Meaning	
91119	Altitude in feet	RECCO Report without RADAR Data
92229	Altitude in meters	
93339	Pressure (mbs.)	
94449	Not assigned	
95559	Not assigned	
96669	Altitude in feet	RECCO Report with RADAR Data
97779	Altitude in meters	
98889	Pressure (mbs.)	
99999	Not assigned	

TABLE 2: i_u

0 ℃., No humidity report
1 ℃., Relative humidity
2 ℃., Diff. between dry bulb and wet bulb temp.
3 ℃., Diff. between dry bulb and dew point temp.
4 ℃., Dew point

TABLE 3: Y

1 Sunday
2 Monday
3 Tuesday
4 Wednesday
5 Thursday
6 Friday
7 Saturday

TABLE 4: Q

Code	Longitude	
0	0° - 90°W	North Latitude
1	90° - 180°W	
2	180° - 90°E	
3	90° - 0°E	
4		
5	0° - 90°W	South Latitude
6	90° - 180°W	
7	180° - 90°E	
8	90° - 0°E	

TABLE 5: B

0 None
1 Light turbulence
2 Mod. tur. in clear air, infrequent
3 Mod. tur. in clear air, frequent
4 Mod. tur. in cloud, infrequent
5 Mod. tur. in cloud, frequent
6 Severe tur. in clear air, infrequent
7 Severe tur. in clear air, frequent
8 Severe tur. in cloud, infrequent
9 Severe tur. in cloud, frequent

TABLE 6: f'_c

0 Total amount of cloud less than 1/8
1 Total cloud amount at least 1/8, with either 1/8 - 4/8 above or 1/8 - 4/8 below, or combinations thereof
2 Cloud amount more than 4/8 above and 0 - 4/8 below
3 Cloud amount 0 - 4/8 above and more than 4/8 below
4 Cloud amount more than 4/8 above and more than 4/8 below
5 Chaotic sky - many undefined layers
6 In and out of clouds, on instruments 25% of time
7 In and out of clouds, on instruments 50% of time
8 In and out of clouds, on instruments 75% of time
9 In clouds all of the time, continuous instrument flight
/ Impossible to determine due to darkness

TABLE 7: d_t

Code	Meaning	
0	Spot wind	
1	Winds averaged over 100 naut. miles preceding last fix	Last fix 25 naut. miles prior to this position
2	Winds averaged over 200 naut. miles preceding last fix	
3	Winds averaged over 300 naut. miles preceding last fix	
4	Winds averaged over 400 naut. miles preceding last fix	
5	Winds averaged over 100 naut. miles preceding last fix	Last fix 75 naut. miles prior to this position
6	Winds averaged over 200 naut. miles preceding last fix	
7	Winds averaged over 300 naut. miles preceding last fix	
8	Winds averaged over 400 naut. miles preceding last fix	
9	Winds averaged over more than 400 nautical miles	

TABLE 8: d_a

0 90% to 100% reliable
1 75% to 100% reliable
2 80% to 100% reliable
3 75% to 90% reliable
4 80% to 80% reliable
5 50% to 75% reliable
6 Less than 50% reliable
7 No reliability
8 No wind
9 Not used (See Note 15)

TABLE 9: w

0 Clear (no cloud at any level)
1 Partly cloudy (scattered or broken)
2 Continuous layer(s) of cloud(s)
3 Sandstorm, duststorm, or storm of drifting snow
4 Fog, thick dust, or haze
5 Drizzle
6 Rain
7 Snow or rain and snow mixed
8 Shower(s)
9 Thunderstorm(s)

TABLE 10: m

0 Light intermittent
1 Light continuous
2 Moderate intermittent
3 Moderate continuous
4 Heavy, intermittent
5 Heavy continuous
6 With rain
7 With snow
8 With hail
9 No remarks

TABLE 11: j

0 Surface pressure in whole millibars, thousands figure omitted
1 Altitude of 1,000 mb surface in geopotential meters; if negative add 500
2 Altitude of 850 mb surface in geopotential meters; if negative add 500
3 Altitude of 700 mb surface in geopotential meters
4 Altitude of 500 mb surface in geopotential decameters
5 Altitude of 300 mb surface in geopotential decameters
6 Altitude of 200 mb surface in geopotential decameters
7 Altitude of 100 mb surface in geopotential decameters
8 True altitude (radio altimeter or other method) minus pressure altitude (set at 1,013 mb) in tens of feet; if negative add 500 to absolute value (e.g. -- (minus) 100 is reported as 600)
9 Altimeter sub-scale reading in whole millibars, thousands figure omitted

TABLE 12: N_1, N_2, N_3

Code	Tenths	Oktas
0	Zero	Zero
1	1/10 or less, but not zero	1 Okta or less but not zero
2	2/10 and 3/10	2 Oktas
3	4/10	3 Oktas
4	5/10	4 Oktas
5	6/10	5 Oktas
6	7/10 and 8/10	6 Oktas
7	9/10 or more, but not 10/10	7 Oktas or more, but not 8 Oktas
8	10/10	8 Oktas
9	Sky obscured, or cloud amount cannot be estimated	

TABLE 13: C

0 Cirrus (Ci)
1 Cirrocumulus (Cc)
2 Cirrostratus (Cs)
3 Altocumulus (Ac)
4 Altostratus (As)
5 Nimbostratus (Ns)
6 Stratocumulus (Sc)
7 Stratus (St) or Fractostratus (Fs)
8 Cumulus (Cu) or Fractocumulus (Fc)
9 Cumulonimbus (Cb)
/ Cloud not visible owing to darkness fog, duststorm, sandstorm, or other analogous phenomena

TABLE 14: hh, HH, $h_i h_i$, $H_i H_i$

Code	Altitude	Code	Altitude
00	Less than 100 ft. (30 m)	57	7,000 ft. (2,100 m)
01	100 ft. (30 m)	etc.	etc.
02	200 ft. (60 m)	78	28,000 ft. (8,400 m)
03	300 ft. (90 m)	79	29,000 ft. (8,700 m)
04	400 ft. (120 m)	80	30,000 ft. (9,000 m)
05	500 ft. (150 m)	81	35,000 ft. (10,500 m)
etc.		82	40,000 ft. (12,000 m)
49	4,900 ft. (1,470 m)	etc.	etc.
50	5,000 ft. (1,500 m)	87	65,000 ft. (19,500 m)
51	Not specified	88	70,000 ft. (21,000 m)
etc.	etc.	89	Above 70,000 ft. (21,000 m)
55	Not specified		
56	6,000 ft. (1,800 m)	//	Unknown

TABLE 15: D, D_K, D_w

0 Calm or stationary (or at the station)
1 NE
2 E
3 SE
4 S
5 SW
6 W
7 NW
8 N
9 All directions, no definite direction, or unknown, or no report

TABLE 16: F

0 Calm
1 1 - 3 knots
2 4 - 6 knots
3 7 - 10 knots
4 11 - 16 knots
5 17 - 21 knots
6 22 - 27 knots
7 28 - 33 knots
8 34 - 40 knots
9 41 - 47 knots or over*

* See Note 30

TABLE 17: S

0 Calm (glassy)
1 Calm (rippled) (0 - 1 ft.)
2 Smooth (wavelets) (1 - 2 ft.)
3 Slight (2 - 4 ft.)
4 Moderate (4 - 8 ft.)
5 Rough (8 - 13 ft.)
6 Very rough (13 - 20 ft.)
7 High (20 - 30 ft.)
8 Very high (30 - 45 ft.)
9 Phenomenal* (Over 45 ft.)

*As might exist at the center of a hurricane

TABLE 18: W_s

0 No change
1 Marked wind shift
2 Marked turbulence begins or ends
3 Marked temperature change (not with altitude)
4 Precipitation begins or ends
5 Change in cloud forms
6 Fog bank begins or ends
7 Warm front
8 Cold front
9 Front, type not specified

TABLE 19: S_s, S_b, S_e

0 No report
1 Reported at previous position
2 Occurring at present position
3 20 nautical miles
4 40 nautical miles
5 60 nautical miles
6 80 nautical miles
7 100 nautical miles
8 150 nautical miles
9 More than 150 nautical miles

TABLE 20: W_c

0 No report
1 Signs of hurricane
2 Ugly, threatening sky
3 Duststorm or sandstorm
4 Fog or ice fog
5 Waterspout
6 Cs cloud shield or bank
7 As or Ac cloud shield or bank
8 Line of heavy cumulus
9 Cb heads or thunderstorms

TABLE 21: I_r

0 .1 in. or 2 mm./minute
1 .1 - .2 in. or 2 - 5 mm./minute
2 .3 - .4 in. or 6 - 10 mm./minute
3 .5 - .6 in. or 11 - 15 mm./minute
4 .7 - .8 in. or 16 - 20 mm./minute
5 .9 - 1.0 in. or 21 - 25 mm./minute
6 Over 1.0 in. or 25 mm./minute
7 Light
8 Moderate
9 Heavy

TABLE 22: I_t

0 None
1 Rime ice in clouds
2 Clear ice in clouds
3 Combination rime and clear ice in clouds
4 Rime ice in precipitation
5 Clear ice in precipitation
6 Combination rime and clear ice in precipitation
7 Frost (icing in clear air)
8 Non-persistent contrails
9 Persistent contrails

TABLE 23: O_e

0 Circular Area
1 NNE - SSW
2 NE - SW
3 ENE - WSW
4 E - W
5 ESE - WNW
6 SE - NW
7 SSE - NNW
8 S - N
9 Uncertain

TABLE 24: c_e

0 Not reported or indeterminate
1 Scattered
2 Solid
3 Scattered line
4 Solid line
5 Scattered, all quadrants
6 Solid, all quadrants
7
8
9

TABLE 25: i_e

0 No report or unknown
1 Weak, decreasing
2 Weak, no change
3 Weak, increasing
4 Moderate, decreasing
5 Moderate, no change
6 Moderate, increasing
7 Strong, decreasing
8 Strong, no change
9 Strong, increasing

NOTES

General:

1. The code name RECCO is used as a prefix to the report, indicating that it is a report from meteorological reconnaissance flight.
2. Present weather, cloud genera and amounts, turbulence, and surface data are reported for a cylindrical portion of the atmosphere approximately 30 nautical miles in radius with the aircraft at the center at the time of observation. The lentgh of this cylinder extends from the earth's surface to the top of the atmosphere. Weather beyond the circumference of the observation cylinder is reported as off course weather.
3. The use of Section 1 is MANDATORY and all the groups are always included in the message. If datum is not available for an element, a solidus (/), or a code figure if appropriate, is reported for the element to indicate missing.
4. The use of Section 2 is OPTIONAL. If Section 2 is used all of the groups for which data are observed shall be included in the message. The groups in Section 2 are self-identifying; therefore, they can be omitted from, included in, or repeated (as required) in the message without confusion.

NOTES CONTINUED ON REVERSE

5. Plain language remarks may be added at the end of the message to supplement the coded message or to supply additional information not provided for in the code.

6. The solidus (/) will be used to report missing or unknown data unless otherwise specified for the individual elements. The term "altitude" is defined as the vertical distance of a level point or an object considered as a point, measured from mean sea level.

7. If operational data or position reports are required, they will be transmitted by the aircraft prior to the 9xxx9 key group of the RECCO report. These additional operational reports will not be included in the landline teletypewriter transmission of the RECCO report.

SECTION 1 - MANDATORY Section of the Flight Level Portion of the Message.

8. 9xxx9 - The key group 9xxx9 indicates the dimensional unit being used and whether or not radar observations are being made. This group shall always be included in the report. If radar equipment is operational, this information shall be reported for symbol "xxx" even though no echoes are observed. The omission of the 8-groups from the report will indicate to the recipient that no echoes were observed. (Note: The units indicated by symbol "xxx" apply only to the flight level portions of the message. All altitudes of standard pressure surfaces and tropopause reported in the sounding portion of the message are given in meters and decameters in accord with the instructions given in the Manual for Radiosonde Code for reporting sounding data.)

9. GGgg and Y - The time the aircraft is on the vertical axis of the observation cylinder is reported for "GGgg". All elements are observed, insofar as practicable, when the aircraft is at the point of observation or in proximity thereto. The actual time of observation is the time at which the observing of all elements is completed. All times (GGgg) and the day of the week (Y) are given in Greenwich Mean time. The day reported for Y is the day on which the observation is taken and NOT the day on which it is transmitted.

10. $L_aL_aL_a$ and $L_oL_oL_o$ - The latitude and longitude of the point, at which the flight level observation is made, are reported for "$L_aL_aL_a$" and "$L_oL_oL_o$" respectively. Tenths of a degree are obtained by dividing the number of minutes by 6, disregarding the remainder. The hundreds digit is omitted from longitudes 100° to 180°, inclusive.

11. B - The type of turbulence encountered at the time of observation is reported for "B". Definitions of the terms used to indicate the various types of turbulence reported are:

Light - A turbulent condition during which occupants may be required to use seat belts, but objects in the aircraft remain at rest.

Moderate - A turbulent condition in which occupants require seat belts and occasionally are thrown against the belt. Unsecured objects in the aircraft move about.

Severe - A turbulent condition in which the aircraft momentarily may be out of control. Occupants are thrown violently against the belt and back into the seat. Objects are secured in the aircraft are tossed about.

12. f'_c - The average flight condition existing during the time required to make the flight level observation is reported for "f'_c".

13. hhh - The true altitude of the aircraft at the time of the flight level observation is reported to the nearest hundred foot or 30 meter level (e.g., when the aircraft is 50 feet or more above a hundred foot level the next higher level is reported for "hhh").

14. d_t - When code figure 9 is reported, the distance over which the wind is averaged is added at the end of the message in plain language.

15. d_a and ddfff - When code figure 8 is reported for "d_a", five solidi (i.e., /////) are reported for the "ddfff" group. The complete specifications for Table 7 are:

TABLE 8: d_a

0 90% to 100% reliable. Multiple drift with closed wind star, or small open star when winds are 50 kts or greater. Short radar wind runs.
1 75% to 100% reliable. Multiple drift with small open star or double drift or single drift with average ground speed by timing. Short radar run.
2 80% to 100% reliable. Fix to fix winds using the following pin point visual fixes, radar fixes or accurate loran fixes using good ground waves.
3 75% to 90% reliable. Fix to fix winds using two or three lines of positions (LOPs) either loran, celestial, radio or sight bearings or any combination of the three above when all lines of position are considered reliable.
4 60% to 80% reliable. Winds obtained using single drift and single LOP (Speed Line), air-plot, etc.
5 50% to 75% reliable. Fix to fix winds using two or three lines of position either loran, celestial, radio or sight bearings or any combination of the above when one of the lines is not considered reliable.
6 Less than 50% reliable. Winds obtained by any of the above methods which the navigator believes to be inaccurate or of questionable accuracy.
7 No reliability. Assumed or estimated winds.
8 No wind. Navigator unable to determine a wind.
9 Not used.

16. TT - Free air temperature (corrected for calibration, installation, and dynamic heating effects) at flight level (hhh) at the time of observation is reported for "TT" to the nearest whole degree Celsius.

When the temperature is below zero, 50 is added to the absolute value of the temperature and the sum is reported for "TT". The hundreds figure, if any, resulting from this addition is disregarded.

17. T_dT_d - When the wet bulb temperature is below -35°C., "//" is reported for "T_dT_d". Dew point is used to indicate the moisture content of the air in United States RECCO reports. (See Note 16.)

18. w - The specification most descriptive of the weather existing at the time of observation is reported for "w". Code figure 2 is reported when the total amount of cloud above or below the aircraft is 7/8 or more.

19. m - The information which best amplifies the present weather reported for "w" is reported for "m".

SECTION 2 - OPTIONAL Section of the Flight Level Portion of the Message

20. $Ik_nN_1N_2N_3$ - If data on more than three layers of cloud are reported, a second $Ik_nN_1N_2N_3$ group plus the required number of ChhHH groups are inserted in the message following the last of the first three ChhHH groups. The additional number of layers (i.e., exclusive of the first three layers) being reported is given for "k_n" in the second $Ik_nN_1N_2N_3$ group. The coverage of the additional cloud layers is reported for N_1, N_2, and N_3 in the second group, as required. When no clouds exist the $Ik_nN_1N_2N_3$ and ChhHH groups are omitted from the message.

21. k_n - When clouds are present in indefinite layers (chaotic sky) code figure 9 is reported for "k_n". If it is impossible to determine that clouds exist (due to darkness or for other reasons) a "/" is reported for "k_n". When a cloud layer is present but data on the type, the extent of coverage, and altitude can not be observed, "/'s" are reported for N, C, hh, and HH, as appropriate; however, the layer will be included in the number of layers reported for "k_n". (See Note 22.)

22. N_1, N_2, N_3 - The amount of cloud reported for N_1, N_2, etc., is the amount in the individual layer as though no other cloud were present; i.e., the summation concept is not used. The cloud layers are reported in the message in ascending order according to altitude of the base. When code figure 9 is reported for "k_n", the value reported for "N_1" is the total amount of cloud coverage present and "//" is reported for "N_2N_3". When a "/" is reported for "k_n", "999" is reported for "$N_1N_2N_3$". (See Note 21.)

23. ChhHH - This group is included in the message for each layer of clouds reported by "k_n" and described by N_1, N_2, etc.

24. C - The type of cloud predominating in the layer is reported for "C".

25. hh and HH - The average altitude of both the base and top of the cloud layer reported for "C" is reported for "hh" and "HH", respectively.

26. 4ddff and $5DFSD_K$ - Surface data are reported in this group. Surface wind data are included in each low level report. Either or both of the groups may be included in the message if required.

27. dd - The estimated direction (true) FROM which the surface wind is blowing is reported for "dd". (See Note 28.)

28. ff - The estimated speed of the surface wind is reported for "ff". In the range of 100-199 knots, inclusive, the hundreds figure is omitted and the tens and the units values are reported for "ff" and 50 is added to the value normally reported for "dd". For speeds in excess of 199 knots, "//" is reported for "ff" and the actual speed is reported in plain language at the end of the message.

29. D - The estimated direction (true) FROM which the surface wind is blowing is reported for "D".

30. F - The estimated force of the surface wind is reported. When the speed exceeds Force 9, code figure 9 is reported for "F" and a plain language remark is added at the end of the flight level portion of the message giving the actual Beaufort Force as "GALE TEN", "STORM ELEVEN", or "HURRICANE TWELVE".

31. D_K - The true direction FROM which the swell is moving is reported for "D_K". Code figure 0 is reported for "no swell" and code figure 9 is reported to indicate "confused" swell. When the waves are from several directions, the direction from which the wave of longest period is traveling is reported.

32. $6W_sS_sW_cD_w$ - Two 6-groups may be included in the message to report two significant weather changes, and/or two weather phenomena off course, or combinations thereof.

33. W_s - Significant weather changes which have occurred since the last observation, or in the preceding hour (whichever period is shorter) along the track of the aircraft are reported for "W_s".

34. S_s - The distance from the present position back to the location of the significant weather change (W_s) is reported for "S_s".

35. W_c - Any off-course weather condition of importance which is not included or implied in the specification reported for present weather, will be reported for "W_c". The information reported for "W_c" supplements the present weather (w). (See Notes 2, 18, 54 and 55.)

36. D_w - Code figure 9 indicates "in all directions".

37. $7I_rI_tS_bS_e$ $7h_ih_iH_iH_i$ - When icing occurs, both of the 7-groups shall be included in the report. The 8-groups may be repeated as often as necessary to describe the icing conditions encountered.

38. I_r - Normally only aircraft equipped with icing rate meters will report code figures 0 through 6; however, if a quantitative estimate is possible it may be reported even though the aircraft equipment does not include a meter. In general, code figures 7 through 9 are used more often than the other code figures.

United States definitions of the terms given in Table 21 used to describe the rate of ice accumulation are:

Light - An accumulation of ice which can be disposed of by the aircraft de-icing equipment, which presents no serious hazard to the flight, and which us not sufficient to cause alterations in speed, altitude, or track.

Moderate - An accumulation of ice which produces a condition intermediate between "light" and "heavy".

Heavy - An accumulation of ice which continues to increase despite operation of de-icing equipment, which is sufficiently serious to cause marked alteration in speed, altitude, or track, and which would seriously affect the safety of the aircraft.

39. I_t - For this purpose a non-persistent contrail is defined as one which is 1/4 nautical mile or less in length and a persistent contrail is one which is over 1/4 nautical mile in length.

40. S_b - Code figure 0 is reported when the aircraft has completed an ascent or a descent, in which case the limits of icing are reported in group $7h_ih_iH_iH_i$. Code figure 2 is reported when the icing began during the time of the flight level observation and it will be an amplification of the information reported for "w" and "m".

41. S_e - Code figure 2 is reported when the icing is continuing at the time of the flight level observation.

42. h_ih_i - When the aircraft encounters icing during an ascent or descent, the altitude of the base of the icing stratum is reported for "h_ih_i". When the aircraft encounters icing during level flight, the altitude at which icing occurred is reported for "h_ih_i".

43. H_iH_i - When the aircraft encounters icing during an ascent or descent the altitude of the top of the icing stratum is reported for "H_iH_i". When the aircraft encounters icing during level flight, "//" is reported for "H_iH_i".

44. $8d_rd_rS_rO_e$ $8w_ea_ec_ei_e$ - When radar data are observed, both the 8-groups shall be included in the report. The 8-groups may be repeated as often as necessary to report essential data.

45. d_rd_r - Code figure 99 is reported to indicate echoes "in all directions". (See Notes 8 and 44.)

46. S_r - When the distance to the center of the echo is greater than 95 nautical miles, 100 is subtracted from the distance and the tens value of the remainder is reported for "S_r" and 50 is added to the value normally reported for "d_rd_r". When a line of echoes is observed, "S_r" is the distance to the midpoint of the line.

47. c_e - The term solid is used when the individual echoes are not distinctly and widely separated. Code figures 1, 2, 5, and 6 are used to report circular areas of echoes.

SECTION 3 - Intermediate Reports (OPTIONAL)

48. When required, intermediate observations may be taken between complete flight level observations. The intermediate data are reported in the next complete flight level message by inserting the coded groups (i.e., Section 3) in the message immediately following the last coded group of the complete flight level report. Section 3 may be attached at the end of either Section 2 or Section 1, as appropriate.

49. The use of Section 3 is OPTIONAL. If this Section is reported, all of the data groups (i.e., $GGggi_u$ through mjHHH) shall be always included in the message for each intermediate observation being reported with appropriate missing indicators being used for those elements for which datum is not available except the $(4L_aL_aL_oL_o)$ group. The self-identifying 4-group may be included or omitted as required.

50. The intermediate data groups are extracted from the complete flight level form as follows: 99999 $GGggi_u$ ddfff TTT_uT_uw mjHHH $(4L_aL_aL_oL_o)$ $GGggi_u$ ddfff ..... etc. .....

51. Unless otherwise indicated it shall be assumed that a straight-line constant-altitude flight has been made between the position of the last reported complete flight level observation and the present one. Any intermediate observations reported in the present complete flight level report shall be assumed to have been made on this flight patch.

52. If the direction of the flight has been altered, the latitude and longitude of the turning point shall be reported by the group $(4L_aL_aL_oL_o)$. The group $(4L_aL_aL_oL_o)$ shall be inserted in the Intermediate Reports portion of the message, as appropriate, with respect to time.

53. If the altitude of the flight is altered between any two consecutive complete flight level observations, intermediate observations shall not be reported between those two flight level reporting positions.

Plain Language Remarks

54. Plain language remarks may be added at the end of the message to supplement the coded data or to supply additional information of importance not provided for in the code. For example: Time of occurrence of significant weather (W_s), past weather, etc.

55. If information on past weather is added as a plain language remark, the most significant weather encountered since the last report, or in the last hour, whichever period of time is shorter, shall be described by the remark.

Sounding Portion of the Message

56. Sounding data are obtained during vertical ascents or descents of the aircraft or by releasing dropsondes from the aircraft. For transmission purposes these data may be added to Section 2 of RECCO or sent as a separate message.

57. Vertical ascent or descent. WMO code form FM 35.C (TEMP) shall be used to report sounding data obtained by means of either a vertical ascent or descent.

a. If the sounding data are added to the flight level report, they shall be added to Section 2 of RECCO and identified by the indicator group 17171. In this instance the groups M_iM_i and (II)iii shall be omitted from FM 35.C and the group $GGh_1h_1h_1$ shall become $00h_1h_1h_1h_1$. The form being ..... $8w_ea_ec_ei_e$ 17171 $00h_1h_1h_1$ $(T_1T_1T_{d1}T_{d1}T_{x1})$ $(0d_1d_1f_1f_1)$ $P_2P_2h_2h_2h_2$ ..... etc.

In this instance the time and position of the ascent or descent shall be given in groups $GGggi_u$ $YQL_aL_aL_a$ $L_oL_oL_oBf'_c$ of the flight level report.

b. When the data obtained by means of a vertical ascent or descent are sent as a separate report, the first four groups of Section 1 of RECCO shall be followed by FM 35.C as follows: 9xxx9 $GGggi_u$ $YQL_aL_aL_a$ $L_oL_oL_oBf'_c$ 17171 ..... etc.

58. Dropsonde. Sounding data obtained from a drop-sonde released from the aircraft shall be reported by means of WMO code form FM 36.C (TEMP SHIP). The drop-sonde data may be added either to the flight level report or sent as a separate report.

a. When the drop-sonde data are added to Section 2 of RECCO the indicator group 71717 precedes the coded sounding data (FM 36.C). In this instance two minor alterations are made in FM 36.C, the M_iM_i group is omitted from the report and GG is reported to the nearest quarter hour. The nearest quarter of an hour is indicated by adding 25, 50 or 75 to the actual number of hours.

When the minute lies between 52 1/2 and 07 1/2 minutes, nothing is added to the hour; e.g., times between 0152 1/2 to 0207 1/2 are coded 02. When the minute lies between 07 1/2 and 22 1/2 minutes, 25 is added to the hour; e.g., times between 0307 1/2 to 0322 1/2 are coded 28. When the minute lies between 22 1/2 and 37 1/2 minutes 50 is added to the hour; e.g., times between 1122 1/2 to 1137 1/2 are coded 61. When the minute lies between 37 1/2 to 52 1/2 minutes 75 is added to the hour; e.g., times between 2037 1/2 to 2052 1/2 are coded 95.

b. When the drop-sonde data are sent as a separate report, the TEMP SHIP form of message (FM 36.C) is preceded by the key groups 9xxx9 and 71717.

c. The location and time (to the nearest quarter hour) at which the drop-sonde was ejected from the aircraft shall be given in the $YOL_aL_aL_a$ and $L_oL_oL_oGG$ groups of TEMP SHIP (FM 36.C).

59. Following are general notes which apply to the coding of sounding data obtained by aircraft:

a. Whenever practicable extrapolated data are reported for $P_oP_oP_o$, T_oT_o and $T_{do}T_{do}$. If extrapolated data are not available for these elements, the surface groups are omitted from the report.

b. If tenths values of air and dew point temperatures are not reported, a zero is coded for T_{xo}, T_{x1}, T_{x2}, etc.

60. Sea Ice Data:

Sea ice, as observed by aircraft, are reported in the national code from (see Chapter III, Part A-4-RECCO).

DATE ______________ TYPE A/C ______________

ORGANIZATION ______________ OBSERVER ______________

Section 2 — OPTIONAL

...s of degrees true) / ...al Surface (knots)	Group Indicator	Direction of Surface Wind	Force of Surface Wind	State of Sea	Direction of Swell	Group Indicator	Significant Changes in Weather	Distance of Occurrence of Ws	Weather Off Course	Bearing (true) of Weather Off Course	Group Indicator	Rate of Icing	Type of icing and contrails	Distance to Beginning of Icing	Distance to Ending of Icing	Group Indicator	Altitude of Base of Icing	Altitude of Top of Icing	Group Indicator	Bearing of Echo Center from Aircraft (10s of degrees, true)	Distance to Echo Center (10s of naut. mi.)	Orientation of Ellipse	Group Indicator	Ellipse Width or Echo Diameter (10s of naut. mi.)	Length of Major Axis (10s of naut. mi.)	Character of Echo	Intensity of Echo	Plain Language Remarks
	D	F	S	D_K	6	W_S	S_S	W_C	D_W	7	I_r	I_t	S_b	S_e	7	h_ih_i	H_iH_i	8	d_rd_r	S_r	O_e	8	w_e	a_e	c_e	i	
	15	16	17	15		18	19	20	15		21	22	19			14					23				24	25	

59. Following are general notes which apply to the coding of sounding data obtained by aircraft:

a. Whenever practicable extrapolated data are reported for $P_oP_oP_o$, T_oT_o and $T_{do}T_{do}$. If extrapolated data are not available for these elements, the surface groups are omitted from the report.

b. If tenths values of air and dew point temperatures are not reported, a zero is coded for T_{x0}, T_{x1}, T_{x2}, etc.

60. Sea Ice Data:

Sea ice, as observed by aircraft, are reported in the national code form (see Chapter III, Part A-4-RECCO).

APPENDIX X

BATHYTHERMOGRAPH LOG (OCEANAV 3167/1)

FORM APPROVED
OMB NO. 41R2645

IYTHERMOGRAPH LOG

repared by the OCEANOGRAPHER OF THE NAVY
TIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ı accordance with specifications established by the
OVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)
VORLD METEOROLOGICAL ORGANIZATION (WMO)

FOR NAVY AIRCRAFT USE

		SQDN TYPE	SQDN NMBR	SORTIE NUMBER	YR	MON		
B	A						Ƶ	T
1	2	3 - 4	5 - 7	8 - 11	12	13 - 14	15	22

III. RADIO MESSAGE INFORMATION

1 MESSAGE PREFIX	2 DATE (GMT)	3 TIME (GMT)	Q U A D / 4 LATITUDE	5 LONGITUDE	6 INDICATOR GRDUP
M_i M_i M_j M_j	DAY MONTH YR	HOUR MIN	DEG MIN	DEG. MIN.	
	Y Y M M J	G G g g	Q_c L_o L_o L_o L_o	L_o L_o L_o L_o L_o	
J J X X		/			8 8 8 8 8
	16 17	18 - 21	23 - 27	28 - 32	

BATHYTHERMOGRAPH TRACE READINGS

DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP
Z_o Z_o T_o T_o T_o	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
0 0					
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	RADID CALL
18 - 42	43 - 47	48 - 52	53 - 57	58 - 62	63 - 67

1 MESSAGE PREFIX	2 DATE (GMT)	3 TIME (GMT)	Q U A D / 4 LATITUDE	5 LONGITUDE	6 INDICATDR GRDUP
M_i M_i M_j M_j	DAY MONTH YR	HOUR MIN	DEG MIN	DEG. MIN	
	Y Y M M J	G G g g	Q_c L_o L_o L_o L_o	L_o L_o L_o L_o L_o	
J J X X		/			8 8 8 8 8
	16 17	18 - 21	23 - 27	28 - 32	

BATHYTHERMOGRAPH TRACE READINGS

DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP
Z_o Z_o T_o T_o T_o	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
0 0					
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	RADIO CALL
18 - 42	43 - 47	48 - 52	53 - 57	58 - 62	63 - 67

1 MESSAGE PREFIX	2 DATE (GMT)	3 TIME (GMT)	Q U A D / 4 LATITUDE	5 LONGITUDE	6 INDICATOR GRDUP
M_i M_i M_j M_j	DAY MONTH YR	HOUR MIN	DEG MIN	DEG MIN	
	Y Y M M J	G G g g	Q_c L_o L_o L_o L_o	L_o L_o L_o L_o L_o	
J J X X		/			8 8 8 8 8
	16 17	18 - 21	23 - 27	28 - 32	

BATHYTHERMOGRAPH TRACE READINGS

DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP	DEPTH TEMP
Z_o Z_o T_o T_o T_o	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
0 0					
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	RADIO CALL
- 42	43 -	48 - 52	53 - 57	58 - 62	63 - 67

OCEANAV 3167/1(6–72)
NOAA Form 77–22 (1–72)

FORM APPROVED
OMB NO. 41R2645

BATHYTHERMOGRAPH LOG

Prepared by the OCEANOGRAPHER OF THE NAVY
and the NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
in accordance with specifications established by the
INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)
and WORLD METEOROLOGICAL ORGANIZATION (WMO)

FOR NAVY SHIP USE

		SHIP TYPE	HULL NUMBER	YR	MON		
B	A					Ƶ	T
1	2	3 - 4	5 - 7	12	13 - 14	15	22

FOR NAVY AIRCRAFT USE

		SQDN TYPE	SQDN NMBR	SORTIE NUMBER	YR	MON		
B	A						Ƶ	T
1	2	3 - 4	5 - 7	8 - 11	12	13 - 14	15	22

I. REFERENCE INFORMATION

PLATFORM		
TYPE	NAME	DESIGNATOR
COUNTRY		INSTITUTION
CRUISE NUMBER	PROJECT	
STATION NUMBER	OBSERVATION NUMBER	INSTRUMENT

II. OPTIONAL ENVIRONMENTAL INFORMATION

DEPTH TO BOTTOM (METERS) 1	WIND 2				SEA LEVEL PRESSURE 3				AIR TEMP 4				AIR TEMP 5			
		DIR		SPEED					±	DRY BULB			±	WET BULB		
	i_u	d	d	f	f	P	P	P	P	S_n	T	T	T	S_n	T	T	T

SEA TEMP 6				WAVE 7				SWELL 8					SOLAR 9	10		11
°C			INSTR	PER		HT		DIR		PER	HT		RADIATION	PRECIP		TRANS
T_w	T_w	T_w		P_w	P_w	H_w	H_w	d_w	d_w	P_w	H_w	H_w	LANG/MIN	R	R	METERS

I. REFERENCE INFORMATION

STATION NUMBER	OBSERVATION NUMBER	INSTRUMENT

II. OPTIONAL ENVIRONMENTAL INFORMATION

DEPTH TO BOTTOM (METERS) 1	WIND 2				SEA LEVEL PRESSURE 3				AIR TEMP 4				AIR TEMP 5			
		DIR		SPEED					±	DRY BULB			±	WET BULB		
	i_u	d	d	f	f	P	P	P	P	S_n	T	T	T	S_n	T	T	T

SEA TEMP 6				WAVE 7				SWELL 8					SOLAR 9	10		11
°C			INSTR	PER		HT		DIR		PER	HT		RADIATION	PRECIP		TRANS
T_w	T_w	T_w		P_w	P_w	H_w	H_w	d_w	d_w	P_w	H_w	H_w	LANG/MIN	R	R	METERS

I. REFERENCE INFORMATION

STATION NUMBER	OBSERVATION NUMBER	INSTRUMENT

II. OPTIONAL ENVIRONMENTAL INFORMATION

DEPTH TO BOTTOM (METERS) 1	WIND 2				SEA LEVEL PRESSURE 3				AIR TEMP 4				AIR TEMP 5			
		DIR		SPEED					±	DRY BULB			±	WET BULB		
	i_u	d	d	f	f	P	P	P	P	S_n	T	T	T	S_n	T	T	T

SEA TEMP 6				WAVE 7				SWELL 8					SOLAR 9	10		11
°C			INSTR	PER		HT		DIR		PER	HT		RADIATION	PRECIP		TRANS
T_w	T_w	T_w		P_w	P_w	H_w	H_w	d_w	d_w	P_w	H_w	H_w	LANG/MIN	R	R	METERS

REMARKS:

III. RADIO MESSAGE INFORMATION

1 MESSAGE PREFIX	2 DATE (GMT)	3 TIME (GMT)	QUAD / 4 LATITUDE	5 LONGITUDE	6 INDICATOR GROUP
	DAY / MONTH / YR.	HOUR / MIN.	DEG. / MIN.	DEG. / MIN.	
M_i M_i M_j M_j	Y Y M M J	G G 9 9	Q_c L_a L_a L_a L_a	L_o L_o L_o L_o L_o	
J J X X		/			8 8 8 8 8
	16 17	18 – 21	23 – 27	28 – 32	

BATHYTHERMOGRAPH TRACE READINGS

DEPTH / TEMP	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.
Z_o Z_o T_o T_o T_o	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
0 0					
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	RADIO CALL
38 – 42	43 – 47	48 – 52	53 – 57	58 – 62	63 – 67

1 MESSAGE PREFIX	2 DATE (GMT)	3 TIME (GMT)	QUAD / 4 LATITUDE	5 LONGITUDE	6 INDICATOR GROUP
	DAY / MONTH / YR.	HOUR / MIN.	DEG. / MIN.	DEG. / MIN.	
M_i M_i M_j M_j	Y Y M M J	G G 9 9	Q_c L_a L_a L_a L_a	L_o L_o L_o L_o L_o	
J J X X		/			8 8 8 8 8
	16 17	18 – 21	23 – 27	28 – 32	

BATHYTHERMOGRAPH TRACE READINGS

DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.
Z_o Z_o T_o T_o T_o	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
0 0					
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	RADIO CALL
38 – 42	43 – 47	48 – 52	53 – 57	58 – 62	63 – 67

1 MESSAGE PREFIX	2 DATE (GMT)	3 TIME (GMT)	QUAD / 4 LATITUDE	5 LONGITUDE	6 INDICATOR GROUP
	DAY / MONTH / YR	HOUR / MIN	DEG. / MIN	DEG. / MIN.	
M_i M_i M_j M_j	Y Y M M J	G G 9 9	Q_c L_a L_a L_a L_a	L_o L_o L_o L_o L_o	
J J X X		/			8 8 8 8 8
	16 17	18 – 21	23 – 27	28 – 32	

BATHYTHERMOGRAPH TRACE READINGS

DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.	DEPTH / TEMP.
Z_o Z_o T_o T_o T_o	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
0 0					
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z
Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	Z Z T_z T_z T_z	RADIO CALL
38 – 42	43 –	48 – 52	53 – 57	58 – 62	63 – 67

APPENDIX XI

WEATHER DATA DESIGNATORS

WEATHER COLLECTIVE HEADINGS

Meteorological weather collectives are listed and identified by means of individual weather headings to facilitate distribution of data by the WMSC, as well as to provide recognition of the data contents; i.e., (1) the type of report (1st and 2nd letters) and geographical designators (3rd and 4th letters), (2) the location identifier, radio call sign, or circuit number indicating the location of origin or location where assembled, and (3) the date-time zone of origin.

TYPE OF REPORT DESIGNATORS
(1st and 2nd letters)

AA	Reserved for WMSC test Messages
AD	Administrative Messages
CI	WMSC Circuit Messages
CO	NMC Circuit Notices
CS	Surface Climate Data
CU	Upper Air Climate Data
DF	Fallout Data
DT	Transosonde Data
IN	International NOTAMS
ME	Meteorological Orders
NO	Meteorological Notices
OS	Ocean Surface Data
S	(Surface Data Observations)
SA	Hourly and/or half-hourly (airway hourly)
SD	Radar
SE	Seismograph earthquake
SF	Atmospherics
SG	Microseismograph
SI	Intermediate hours (3-hourly synoptic)
SM	Main hours (6-hourly synoptic)
SN	Airways Observations Synoptic Code
SO	Oceanographic BATHY reports
SP	Special (aviation hourly)
SR	River and Special Service
SW	Supplementary Airway Weather
SX	Miscellaneous surface
TB	Satellite Location Data
TU	Satellite Vertical Temperature Soundings
TW	Thermal Winds
U	(Upper Air Data Observations)
UA	Aircraft report (PIREP)
UB	ABSTOP
US	Combined pilot balloon and RAWIN collective
UD	Maximum wind
UE	Temp—Temp ship (part D)
UF	Temp—Temp ship (parts C&D)
UG	Pilot—Pilot ship (part B)
UH	Pilot—Pilot ship (part C)
UI	Pilot—Pilot ship (parts A&B)
UJ	Combined RAOB & RAWIN collective
UK	Temp—Temp ship (part B)
UL	Temp—Temp ship (part C)
UM	Temp—Temp ship (parts A&B)
UN	Rocketsonde data
UO	Tropopause
UP	Pilot—Pilot ship (part A)
UQ	Pilot—Pilot ship (part D)
UR	Reconnaissance flight (regular and hurricane)
US	Temp—Temp ship (part A)
UT	CODAR
UV	Vector wind differences
UW	RAWIN (electronic)
UX	Miscellaneous upper air
UY	Pilot—Pilot ship (parts C&D)
WA	AIRMETs
WD	Military tropical island advisory
WH	Hurricane warnings (or advisory)
WO	Tropical Depressions
WS	SIGMETs
WT	Tropical cyclone warning
WW	Warning (other than hurricane)

FORECASTS AND PROGNOSES
(1st and 2nd letters)

FA	Aviation forecasts (comb)
FB	Aviation forecast
FC	TAF—Short period of validity
FD	Winds aloft forecasts
FE	Extended forecast
FF	Flight forecast
FG	Radio warning service (radio propogation forecast)
FH	High altitude forecast
FI	Ice forecast
FJ	Solar Warning Forecast
FK	Smog Pollution Forecast
FM	Temperature extreme forecast
FN	Regional forecasts
FO	Operational forecasts
FP	Public forecasts
FQ	Shipping Forecast Fleet Code

FR	Route forecasts
FS	Surface prognostic chart
FT	TAF—Long period of validity
FU	Upper air prognostic chart
FW	Winter sports forecast with data
FX	Miscellaneous forecasts
FZ	Marine forecasts

ANALYSES
(1st and 2nd letters)

AB	Weather Summaries
AC	Convective analyses
AH	Thickness analysis
AL	Zonal Wind Analyses (Hemispheric)
AS	Surface
AT	Three-hourly analyses
AU	Upper air
AV	Vertical motion analyses
AW	Wind analyses
AX	Miscellaneous
AZ	Zonal analysis (hemispheric)
GF	Computerized Grid Point Winds Analysis
KS	Upper Winds for Oceanic Control

GEOGRAPHICAL DESIGNATORS
(3rd and 4th letters)

AA	Antarctica
AB	Albania
AC	Arctic Region
AD	Democratic Aden
AE	Southeast Africa
AF	Africa
AG	Argentina
AH	Afghanistan
AI	Ascension Island
AK	Alaska
AL	Algeria
AM	Central Africa
AN	Angola
AO	West Africa
AP	Southern Africa
AR	Arabian Sea
AS	Asia
AT	Antigua
AU	Australia
AZ	Azores
BA	Bahamas
BC	Botswana
BD	Lesotho
BE	Bermuda
BG	Guyana
BH	Belize
BI	Burundi
BK	Banks Island
BM	Burma
BN	Bahrain
BO	Bolivia
BQ	Baltic Sea
BR	Barbados
BU	Bulgaria
BV	Bouvet Island
BW	Bangladesh
BX	Belgium and Luxembourg
BY	Byelo-Russian SSR
BZ	Brazil
CA	Caribbean
CD	Democratic Komouchea
CE	Central African Republic
CG	Congo
CH	Chile
CI	China
CL	Sri Lanka
CM	Cayman Island
CN	Canada
CO	Colombia
CR	Spain (Canary Island)
CS	Costa Rica
CT	Canton Island
CU	Cuba
CV	Cape Verde Island
CY	Island of Cyprus
CZ	Czechoslovakia
DD	German Democratic Republic
DG	D. Guiana-Surinam
DH	Dahomey
DK	Democratic Peoples Republic of Korea
DL	Germany (Federal Republic)
DN	Denmark
DO	Dominica
DR	Dominican Republic
EA	East Africa
EC	East China Sea
EE	Eastern Europe
EJ	Fuji Island
EL	Ellice Islands
EM	Middle Europe
EN	Northern Europe
EQ	Ecuador
ER	United Arab Emirates

ET	Ethiopia
EU	Europe
EW	Western Europe
FA	Faroes
FC	Comoro Islands
FE	Far East
FG	French Guiana
FI	Finland
FK	Falkland Islands
FM	French Morocco
FN	Niger
FR	France
FS	Mali
FW	Wallis and Futuna Islands
GA	Gulf of Alaska
GB	Gambia
GC	Ghana
GE	Gough Island
GI	Gibralter
GL	Greenland
GM	Guam
GN	Guinea
GO	Gabon
GR	Greece
GT	Gilbert Islands
GU	Guatemala
GX	Gulf of Mexico
GY	Guyana
HA	Haiti
HE	St. Helena
HK	Hong Kong
HO	Honduras
HU	Hungary
HV	Upper Volta
HW	Hawaiian Islands
ID	Indonesia
IE	Ireland
IL	Iceland
IN	India
IO	Indian Ocean
IQ	Iraq
IR	Iran
IS	Israel
IV	Ivory Coast
IY	Italy
JM	Jamaica
JP	Japan
KA	Caroline Islands
KI	Christmas Island
KK	Cocos Island
KM	Cameroons
KN	Kenya
KO	Korea
KU	Cook Island
KW	Kuwait
LA	Lao Peoples Democratic Republic
LB	Lebanon
LC	St. Lucia
LI	Liberia
LN	Southern Line Islands
LU	Aleutian Islands
LY	Libya
MA	Mauritius
MB	Marion Island
MC	Central Mediterranean
MD	Madeiria
ME	Eastern Mediterranean
MF	St. Martin (French)
MG	Madagascar
MI	Marshall Islands
ML	Malta
MM	Mediterranean
MN	St. Martin (Netherlands)
MO	Mongolia
MR	Martinique
MT	Mauretania
MU	Macau
MV	Maldives
MW	Western Mediterranean
MX	Mexico
MY	Mariana Islands
MZ	Mozambique
NA	North America
NB	North Borneo
NC	New Caledonia & Loyalty Islands
NE	Near East
NG	New Guinea
NH	New Hebrides
NI	Nigeria
NK	Nicaragua
NL	Netherlands
NO	Norway
NP	Nepal
NT	North Atlantic
NU	Netherlands Antilles (Aruba, Bonaire, Curaco)
NZ	New Zealand
OC	Oceana
OF	French Polynesia
OH	Sea of Okhotsk
OM	Oman
OR	South Orkney

OS	Austria
PA	Pacific
PE	Persian Gulf
PG	Guinea
PH	Philippines
PI	Phoenix Island
PK	Pakistan
PL	Poland
PM	Panama
PN	North Pacific
PO	Portugal
PQ	Western North Pacific
PR	Peru
PS	South Pacific
PT	Pitcairn Island
PU	Puerto Rico
PW	Western Pacific
PY	Paraguay
PZ	Eastern Pacific
QT	Qatar
RA	U.S.S.R. (Asia)
RE	Reunion
RH	Zimbabwe
RM	Equatorial Guinea
RN	Malawi
RO	Roumania
RS	U.S.S.R. (Europe)
RW	Rwanda
SA	South America
SC	Seychelles Islands
SD	Saudi Arabia
SE	Southern Ocean Area
SF	Djibouti
SG	Senegal
SI	Somali
SJ	Sea of Japan
SK	Sarawak
SL	Sierra Leone
SN	Sweden
SO	Solomon Islands
SP	Spain
SR	Singapore
SS	South China Sea
ST	South Atlantic
SU	Sudan A.E.
SV	Salvador
SW	Switzerland
SX	Santa Cruz Island
SY	Syrian Arab Republic
SZ	Spitzbergen
TA	Tuamotu Island
TC	Tristan de Cunha
TD	Trinidand and Tobago
TE	Chad
TG	Togo
TH	Thailand
TI	Turks Island
TJ	Jordan
TK	Tokelau Island
TM	Timor
TN	Tanzania (United Republic)
TO	Tonga
TP	San Tome & Principe Islands
TS	Tunisia
TU	Turkey
UB	Egypt
UG	Ugnada
UK	United Kindgom
UR	Ukrainian S.S.R.
US	United States
UY	Uruguay
VI	Virgin Islands
VN	Venezuela
VS	Socialist Republic of Vietnam
WK	Wake Island
WZ	Swaziland
XE	Eastern Hemisphere (between 0 and 180 degrees East)
XN	Northern Hemisphere
XS	Southern Hemisphere
XT	Tropical Belt
XW	Western Hemisphere (between 0 and 180 degrees West)
XX	For use when other designations are not appropriate.
YE	Yemen
YG	Yugoslavia
ZA	South Africa
ZB	Zambia
ZM	Western Samoa

APPENDIX XII

AN NOMENCLATURE SYSTEM

Part 1.—Equipment indicator letters.

Installation	Type of equipment	Purpose
A—Airborne	A—Invisible light, heat radiation.	A—Auxiliary assemblies (not complete operating sets).
B—Underwater mobile, submarine.	C—Carrier.	B—Bombing.
D—Pilotless carrier.	D—Radiac.	C—Communications (receiving and transmitting).
F—Fixed.	E—Nupac (nuclear protection and control).	D—Direction finder, reconnaissance and/or surveillance.
G—Ground, general ground use (includes two or more ground installations).	F—Photographic	E—Ejection and/or release.
K—Amphibious.	G—Telegraph or teletype.	G—Fire control or search-light directing.
M—Ground, mobile (installed as operating unit in a vehicle which has no functions other than transporting the equipment).	I—Interphone and public address.	H—Recording and/or reproducing (graphic meteorological and sound.)
P—Pack or portable (animal or man).	J—Electromechanical (not otherwise covered).	K—Computing.
S—Water surface craft.	K—Telemetering.	M—Maintenance and test assemblies (including tools).
T—Ground, transportable	L—Countermeasure.	N—Navigational aids (including altimeters, beacons, compasses, racons, depth sounding, approach, and landing).
U—General utility (includes two or more general installation classes, airborne, shipboard, and ground)	M—Meteorological.	Q—Special or combination of purposes.
	N—Sound in air.	R—Receiving, passive detecting.
	P—Radar.	S—Detecting and/or range and bearing, search.
	Q—Sonar and underwater sound.	
	R—Radio.	

Part 1.—Equipment indicator letters—Continued

Installation	Type of equipment	Purpose
V—Ground, vehicular (installed in vehicle designed for functions other than carrying electronic equipment, such as tanks).	S—Special types (magnetic, etc.) or combination of types.	T—Transmitting.
W—Water, surface and undersurface.	T—Telephone (wire).	W—Automatic flight or remote control.
	V—Visual and visible lights.	X—Identification and recognition.
	W—Armament (peculiar to armament, not otherwise covered).	
	X—Facsimile or television.	

Part 2—Component indicators.

Component indicator	Family name	Definition of example (not to be construed as limiting the application of the component indicator)
AM	Amplifiers	Power, audio, interphone, radiofrequency, video, etc.
AT	Antenna	Simple: ship or telescopic, loop, dipole, reflector, also transducer, etc.
BA	Battery, primary type	Batteries, battery packs, etc.
BB	Battery, secondary type	Storage batteries, battery packs, etc.
C	Controls	Control box, remote tuning control, etc.
CP	Computers	A mechanical and/or electronic mathematical calculating device.
CV	Converters (electronic)	Electronic apparatus for changing phase or frequency, or from one medium to another.
FR	Frequency measuring devices	Frequency meters, echo boxes, etc.
G	Generators	Electrical power generators without prime movers.

Part 2—Component indicators—Continued

Component indicator	Family name	Definition of example (not to be construed as limiting the application of the component indicator)
ID	Indicating devices	Calibrated dials and meters, indicating lights, etc. (See IP.)
IP	Indicators, cathode ray tube	Azimuth elevation, PPI panoramic, etc.
M	Microphones	Radio telephone, throat, hand, etc.
MD	Modulators	Device for varying amplitude, frequency, or both.
ME	Meters, portable	Multimeters, volt-ohm milliammeters, vacuum tube voltmeters, power meters, etc.
MK	Miscellaneous kits	Maintenance, modification, etc., except tool and crystal.
ML	Meteorological device	Barometer, hygrometer, thermometer, scales, etc.
MT	Mountings	Mountings, racks, frames, stands, etc.
PH	Photographic articles	Camera, projector, sensitometer, etc.
PT	Plotting equipments	Except meteorological boards, maps, plotting table, etc.
R	Receivers	Receivers, all types except telephone.
RD	Recorders-reproducers	Sound, graphic, tape, wire, film, disk facsimile, magnetic, mechanical, etc.
RF	Radiofrequency component	Composite component of RF circuits. (Do not use if better indicator is available.)
RG	Cables and transmissions line, bulk RF	RF cable, waveguide, etc., without terminal.
RO	Recorders	Sound, graphic, tape, wire, film, disk facsimile, magnetic, mechanical, etc.
RR	Reflectors	Target confusion, etc. Except antenna reflectors. (See AT.)
RT	Receiver and transmitter	Radio and radar transceivers, composite transmitters and receivers, etc.

Part 2—Component indicators—Continued

Component indicator	Family name	Definition of example (not to be construed as limiting the application of the component indicator)
S	Shelters	House, tent, protective shelter, etc.
SB	Switchboards	Telephone, fire control, power panel, etc.
SG	Signal generators	Includes test oscillators and noise generators.
SM	Simulators	Flight, aircraft, target, signal, etc.
SN	Synchronizers	Equipment to coordinate two or more functions.
T	Transmitters	Transmitters, all types except telephone.
TA	Telephone apparatus	Miscellaneous telephone equipment.
TD	Timing device	Mechanical and electronic timing devices, range devices, etc.
TF	Transformers	Transformers when used as separate items.
TS	Test equipment	Test and measuring equipment.
TT	Teletypewriter and facsimile apparatus	Miscellaneous tape, teletype, facsimile.

APPENDIX XIII

ELECTRICAL AND ELECTRONIC TERMS

ELECTRICAL AND ELECTRONIC TERMS

ALTERNATING CURRENT (a-c).—Current in which the change-flow periodically reverses, as opposed to direct current (d-c), and whose average value is zero.

AMPLIFIER.—A device used to increase the signal voltage, current, or power, generally composed of a vacuum tube and associated circuit called a stage. It may contain several stages in order to obtain a desired gain.

AMPLITUDE.—The maximum instantaneous value of an alternating voltage or current, measured in either the positive or negative direction.

ANTENNA.—A conductor or system of conductors for radiating or receiving radio waves.

BATTERY.—Two or more primary or secondary cells connected together electrically. The term does not apply to a single cell.

BLACK SIGNAL.—The signal at any point in a facsimile system produced by the scanning of a maximum density area of the chart copy.

CARRIER FREQUENCY.—The frequency of an unmodulated carrier wave. The RF component of a transmitted wave upon which an audio signal or other form of intelligence can be impressed.

CIRCUIT.—The complete path of an electric current.

CIRCUIT BREAKER.—An electromagnetic or thermal device that opens a circuit when the current in the circuit exceeds a predetermined amount.

COAXIAL CABLE.—A transmission line consisting of one conductor, usually a small copper tube or wire, within and insulated from another conductor of large diameter. Radiation from this type of line is practically zero.

CONDUCTOR.—Any material suitable for carrying electric current.

CYCLE.—One complete positive and one complete negative alternation of a current or voltage.

DIPOLE ANTENNA.—An antenna one-half wavelength long.

DIRECT CURRENT.—An electric current that flows in one direction only.

ELECTRON.—A negatively charged particle of matter.

ENERGY.—The ability or capacity to do work.

FREQUENCY.—The number of complete cycles per second existing in any form of wave motion; such as the number of cycles per second of an alternating current.

FREQUENCY METER.—A meter calibrated to measure frequency.

FREQUENCY MODULATION.—The process of varying the frequency of an RF carrier wave in accordance with the amplitude and frequency of an audio signal. The amplitude of the modulated wave stays constant.

FUSE.—A protective device inserted in series with a circuit. It contains a metal that will melt or break when current is increased beyond a specific value for a definite period of time.

GAIN.—The ratio of the output power, voltage, or current to the input power, voltage, or current, respectively.

GENERATOR.—A machine that converts mechanical energy into electrical energy.

GROUND.—A metallic connection with the earth to establish ground potential. Also, a common return to a point of zero potential. The chassis of a receiver or a transmitter is sometimes the common return, and therefore the "ground" of the unit.

HERTZ.—The international unit of frequency. One hertz, abbreviated Hz, is equivalent to one cycle per second.

HETERODYNE.—The production of a difference frequency (beat) by combining two frequencies. The beat frequency, being lower than the original frequency, is more readily amplified.

INTERMEDIATE FREQUENCY.—The fixed frequency to which all RF carrier waves are converted in a superheterodyne receiver.

KILOHERTZ.—One thousand hertz and abbreviated kHz.

LOUDSPEAKER.—A device that converts AF electrical energy to sound energy.

MICRO.—A prefix meaning one-millionth.

MILLI.—A prefix meaning one-thousandth.

MEGAHERTZ.—One million cycles per second and abbreviated MHz.

MICROPHONE.—A device for converting sound energy into AF electrical energy.

MODULATION.—The process of varying the amplitude (amplitude modulation), the frequency (frequency modulation), or the phase (phase modulation) of a carrier wave in accordance with other signals in order to convey intelligence. The modulating signal may be an audiofrequency signal, video signal, or electrical pulses or tones to operate relays, etc.

NEGATIVE CHARGE.—The electrical charge carried by a body which has an excess of electrons.

NEUTRON.—A particle having the weight of a proton but carrying no electric charge. It is located in the nucleus of an atom.

NUCLEUS.—The central part of an atom that comprises protons and neutrons. It is the the part of the atom that has the most mass.

OHM.—The unit of electrical resistance.

OPEN CIRCUIT.—A circuit that does not provide a complete path for the flow of current.

OSCILLOSCOPE.—An instrument for showing visually graphical representations of the waveforms encountered in an electrical circuit.

OUTPUT.—The energy delivered by a device or circuit such as a radio receiver or transmitter.

POSITIVE CHARGE.—The electrical charge carried by a body which has become deficient in electrons.

POWER.—The rate of doing work or the rate of expending energy. The unit of electrical power is the watt.

PROTON.—A positively charged particle in the nucleus of an atom.

PULSATING CURRENT.—A direct current, which periodically increases and decreases in value.

RADIATE.—To send out energy into space, as RF waves.

RADIO.—The science of communications in which RF waves are used to carry intelligence through space.

RADIOFREQUENCY.—Any frequency of electrical energy capable of propagation into space. Frequencies normally are much higher than those associated with sound waves.

RECTIFIERS.—Devices used to change alternating current to unindirectional current. These may be vacuum tubes, semi-conductors such as germanium and silicon, dry-disk rectifiers such as selenium and copper-oxide, and certain other types of crystal.

SHORT WAVE.—Refers to radio operation on frequencies higher than those normally used for commercial broadcasting. The range of frequencies extend from 1500 kc to 30,000 kc.

SUPERHETERODYNE RECEPTION.—A method of receiving radio waves in which the process of heterodyne reception is used to convert the voltage of the received wave into a voltage of an intermediate frequency.

TRANSCEIVER.—A combination of radio transmitting and receiving equipment in a single housing.

TRANSMISSION LINE.—Any conductor or system of conductors used to carry electrical energy from its source to a load.

TRANSMITTER.—Equipment used for generating and amplifying a radiofrequency signal and radiating modulated radiofrequency carrier into space as waves.

TUNING.—The process of adjusting a radio circuit to resonance with the desired frequency.

VOLT.—The unit of electrical potential.

VOLTMETER.—An instrument for measuring an electromotive force, or difference in electrical potential, by volts.

VOLUME.—A term used to denote the sound intensity (amount of radio output) of a receiver or audio amplifier.

WAVE.—A periodic variation of an electrical current or voltage.

WAVELENGTH.—The distance measured in the direction of progression of a wave from any given point to the next point characterized by the same phase.

APPENDIX XIV

STANDARD REPRESENTATION OF ANALYSES AND PROGNOSES

STANDARD REPRESENTATION OF ANALYSES AND PROGNOSES

INFORMATION

The following is the standard representation used by the Aerographer's Mates while attending C-1 and C-7 school at Chanute Air Force Base.

1. Isopleths:

a. Symbols and Colors. Use the following symbols or colors in the order given to draw isopleths, depending on whether a monochromatic or polychromatic system is in use:

Monochromatic	Polychromatic
__________Continuous line	__________Black
---------------Dashed line	__________Red
...............Dotted	__________Green

b. Priority of Isopleths. When two or more systems of isopleths are entered on the same chart, choose the symbol or color in accordance with the following list:

Isobars
Contours
Streamlines
Isotherms
Isotachs
Thickness Lines
Isodrosotherms (lines of equal dew point)
Isallobars

c. Labeling Isopleths. Clearly label isopleths with their values. Label a sufficient number to permit ready identification. Enter the numbers along the isopleths with their bases parallel to the adjacent lines of latitude as far as possible. Indicate their identity by a legend on the chart.

2. Fronts and Allied Phenomena:

a. Analytical Terms. The following are brief descriptions of the terms used in the analysis of charts:

(1) Intertropical convergence zone. A narrow zone where the trades of the two hemispheres meet.

(2) Intertropical discontinuity. A discontinuity separating very hot and dry continental air from the cooler, moist air from equatorial regions.

(3) Subtropical discontinuity. A discontinuity separating very hot and dry continental air from cooler air from higher latitudes.

b. Symbols for Fronts and Allied Phenomena. The symbols shown as Figure XIV-1 will be used to indicate the positions of fronts and allied phenomena on charts. Provision is made for monochromatic methods of representation. The symbol is placed on the chart along the line of the phenomenon. Where an arrow is shown in Figure XIV-1, it simply indicates the orientation of the symbol in relation to the direction of movement of the phenomenon and is not included on the chart. In Figure XIV-1, the phrase "at the surface" implies the intersection of the front with the surface depicted by the chart, and "above the surface" implies the vertical projection of a frontal intersection at a higher level onto the surface depicted by the chart.

3. Weather Features:

Weather features on charts will be shown in the manner indicated in Figure XIV-2.

NOTE: In all cases, the extent of the area affected by the phenomenon may be delineated by a thin boundary line of the same color. The shading, hatching, or superimposed symbols must not obliterate plotted data.

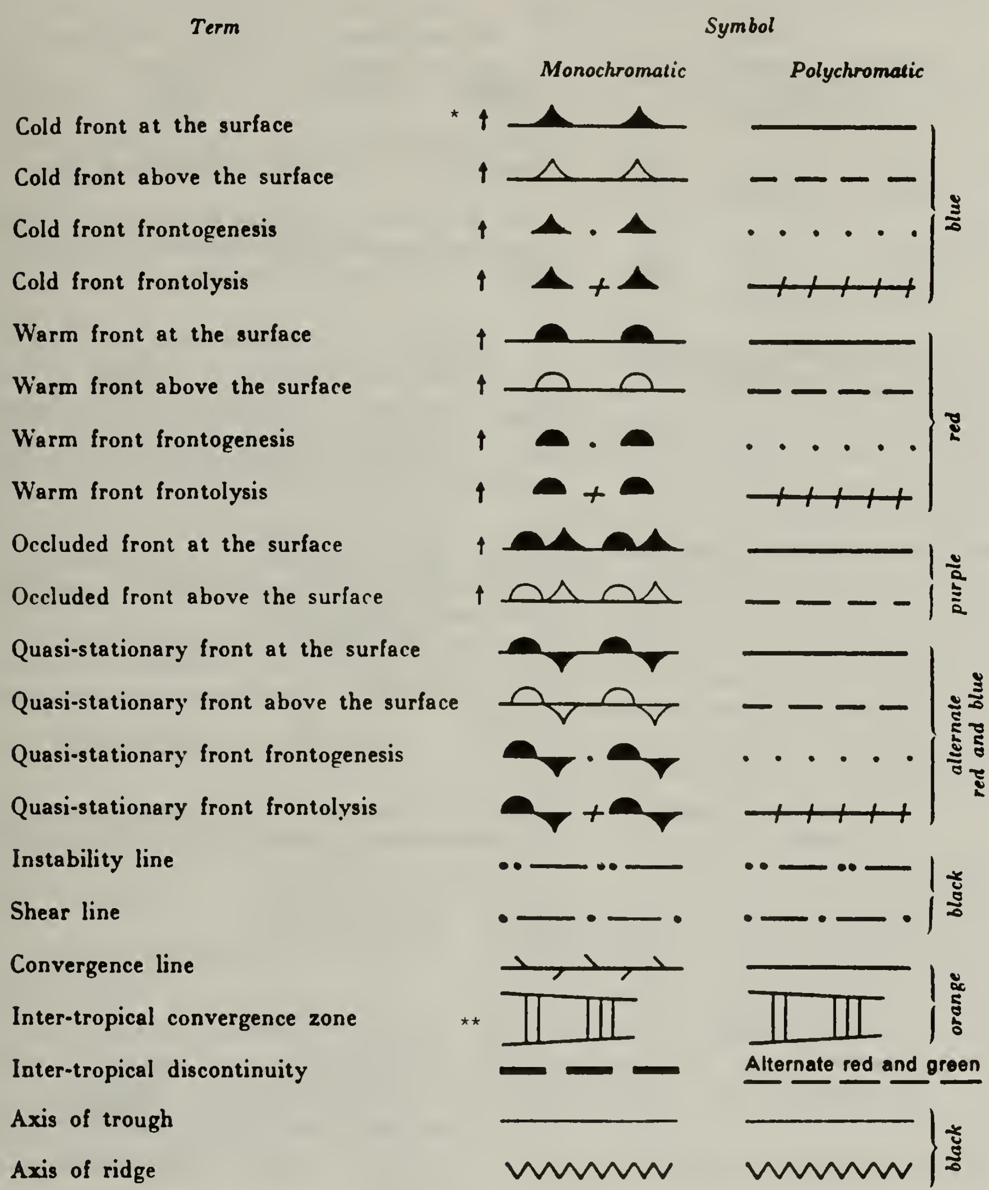
4. Air Masses:

a. Origin. The origin of an air mass is shown by a capital letter as follows:

(1) A—arctic air
(2) P—polar air
(3) T—tropical air
(4) E—equatorial air

b. History (Optional). Indicate the history of the air mass by placing a small letter before the capital letter showing the origin of the air mass as follows:

(1) m—an air mass having continental characteristics.
(2) c—an air mass having continental characteristics.



NOTE: * Where an arrow (↑) is shown it simply indicates the orientation of the symbol in relation to the direction of movement of the phenomenon and is not included on the chart.

** The seperation of the two lines gives a qualitative representation of the width of the zone; the hatched lines may be added to indicate areas of activity.

Figure XIV-1.—Symbols for fronts and allied phenomena.

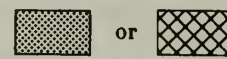
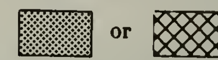
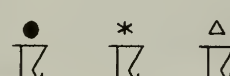
Feature	*Monochromatic*	*Polychromatic*
Zones of continuous precipitation	 Solid shading or cross hatching	 Solid shading or cross hatching in green
	The W symbol appropriate to the type of precipitation may be distributed over the zone, e.g., for drizzle ,, rain ● or snow *.	
Zones of intermittent precipitation	 Single hatching	 Single hatching in green
	The appropriate weather symbol may be distributed over the zone.	
Areas of showers	Large shower symbols distributed over the area with the symbol for rain, snow or hail added as appropriate, e.g., 	As monochromatic system but in green
Areas of thunderstorms	Large thunderstorm symbols distributed over the area with the symbol for rain, snow or hail added as appropriate, e.g., 	As monochromatic system but in red
Areas of fog	Large fog symbols distributed over the area 	 Solid shading in yellow
Areas of duststorm, sandstorm or dust-haze	Large symbols for the appropriate phenomenon distributed over the area 	 Solid brown shading with the appropriate weather symbol distributed over the area

Figure XIV-2.—Weather symbols and shading schemes.

c. Temperature. Add a small letter after the capital letter to indicate whether the temperature of the air mass is higher or lower than the temperature of the underlying surface as follows:

(1) w—if the air is warmer than the underlying surface.

(2) k—if the air is colder than the underlying surface.

NOTE: mPk signifies maritime polar air colder than the surface over which it is passing. Indicate one air mass changing into another with an arrow joining the symbols for the two air masses, e.g., the transitional state between a mass of maritime polar air and a mass of maritime tropical air masses would be shown mP mT. Show the mixing of two air masses by inserting a plus sign between the symbols for the air masses; e.g., mP + mT. To indicate one air mass lying above another, place the letter symbols for the two air masses one above the other and separate them with a horizontal line; e.g., $\frac{\text{mP}}{\text{cPk}}$

5. Analysis on Specific Charts

a. Surface Charts:

(1) Use the symbols given in Figure XIV-1 to show fronts.

(2) Draw isobars in intervals of four or five millibars. Multiples or submultiples of these basic intervals may be used depending on the scale and purposes of the chart; but, whatever the intervals, include the 1,000 millibar isobar in all series.

(3) Indicate the location of a pressure center by the symbol +. Use a capital letter L (red) or H (blue) to indicate the nature of the center.

(4) Use an identifying letter to assist in tracking pressure centers from chart to chart. This letter will be written as a suffix to the letter or symbol defining the pressure center. A tropical cyclonic circulation may have a name or a number assigned to it. Enter this in red block letters near the center.

NOTE: In the case of tropical cyclonic circulations the center is marked as follows:

T.D. Tropical Depression (number) (less than 34 knots)

Tropical Storm (name) (34 through 63 knots)

Typhoon (or hurricane) (name) (64 knots or more)

(5) Enter the value of the pressure at the center in whole millibars immediately below the symbol marking the center, the number being parallel to the adjacent line of latitude.

(6) Enter the previous positions of a pressure center by using the symbol +. Above each symbol enter the corresponding time in hours (two figures) and below it, the pressure of the center at that time im millibars. Join the symbols by a thick broken line (--). Indicate the forecast position of a pressure center by a + symbol in the same way enter the time and the forecast pressure above and below the symbol respectively. Join the present position and the forecast position by a solid arrow drawn along the track the center is forecast to take.

(7) Draw pressure change lines, or isallobars, of 3-hour change for intervals of a single millibar. When the scale of the chart is small or if the period is longer than three hours, use larger intervals. Number the no change line with a zero and precede the numbers on the other lines with a plus sign (+) if the pressure has risen and a minus sign (−) if it has fallen.

b. Charts of Isobaric Surfaces:

(1) Fronts. Use the symbols given in Figure XIV-1.

(2) Contour Lines. Use black ink or pencil and draw lines at intervals of 40 (80, 20, and 10, when appropriate) or 60 geopotential meters (120, 30 and 15, when appropriate), or at intervals of 200 geopotential feet. Number the lines in geodecameters when metric units are used, e.g., 5,280 geopotential meters would be labeled 528. When English units are used number the lines in units of 100 geopotential feet; e.g., 17,600 geopotential feet would be labeled 176.

(3) Streamlines. When used in lieu of contours, enter streamlines with arrowheads to depict the flow direction. Streamline density should be such that wind direction at any point can be easily determined.

(4) Height Centers. The present, past, and forecast positions of high and low height centers in the contour patterns are indicated the same way as pressure centers on surface charts. Enter the value of the height at the center to the nearest 10 meters or to the nearest 100 feet depending on the units used immediately below the symbol marking the center; e.g., 528 (5,280) if in meters and 176 (17,600) if in feet. Enter the number parallel to the adjacent line of latitude. Enter time of past position as day of month/time Z.

(5) Isotachs. Draw isotachs at intervals of 10, 20, or 40 knots. Mark centers of regions of minimum speed with an "S" and centers of regions of maximum speed by a "J" followed by the estimated maximum speed; e.g., J120.

(6) Jet Streams. Signify a jet stream by a heavy red solid line with arrowheads placed at intervals pointing in the direction of the flow.

(7) Isobypses of Relative Topography or Thickness Lines. When thickness lines are drawn, draw them in red: intervals of 30, 60 or 90 geopotential meters are recommended.

(8) Isotherms. Isotherms will not be drawn on charts which contain thickness lines. Isotherms will be drawn in red.

(9) Isodrosotherms. Draw lines of equal dew point in green ink or pencil.

c. Isotach Charts. Complete as indicated in paragraph 5b(5Z) and mark the jet stream as indicated in paragraph 5b(6).

d. Tropopause Charts. Intervals for isopleths showing the tropopause are:

(1) When altitudes of the tropopause are used 1,000 meters or 3,000 feet with additional isopleths at intervals of 500 meters or 1,500 feet when the spacing is wide or irregular.

(2) When pressure values of the tropopause are used 50 millibars with additional isopleths at intervals of 25 millibars when the spacing is wide or irregular.

NOTE: On occasion, a tropopause at two or more levels may exist over the same area of the chart. Two or more sets of intersecting lines may then have to be drawn to give a complete representation of the tropopause field.

e. Pressure-Change Charts:

(1) Pressure-Change Lines or Isallobars. Draw isallobars on pressure-change charts for intervals of one millibar when feasible; otherwise use discretion. When a single color is used, draw the zero change line thicker than the other lines and use a dashed (--) line for negative values. When a polychromatic system is used, use black or purple for the zero line, blue for the lines of positive change and red for those showing negative change. In both systems, label the values of the change lines clearly, preceded by the appropriate positive or negative sign.

(2) Pressure Change Centers. Mark the centers of isallobaric highs with a plus-sign (blue) and the centers of isallobaric lows with a minus sign (red). Connect earlier positions of centers by an arrow with the arrowhead at the current position of the center.

f. Vertical Cross-sections. Cross-section diagrams can be analyzed in a number of ways. They can include frontal surfaces, tropopauses, or areas of cloud, as well as isentropes, or isotachs. On every cross-section diagram the legend must give a complete explanation of the items included in the analysis.

6. Outlining of Weather Areas.

a. Weather Feature Outline. The examples shown in Figure XIV-3 will be used for display purposes to indicate weather areas.

NOTE: When a polychromatic display is desired, the following color code will apply:

a. Thunderstorm/Convective Areas—RED

b. CAT Areas—BLUE

c. Icing Areas—BROWN

d. Precipitation Areas—GREEN

e. Cloud Areas:

(1) Less than 10,000 feet or basic HWD cloud areas—PURPLE

(2) Less than 3,000/3—BLUE

(3) Less than 1,000/1—RED

f. Jet Stream/Max Wind Level—RED

g. Contours/Isotherms/Isotachs—see paragraph 1b.

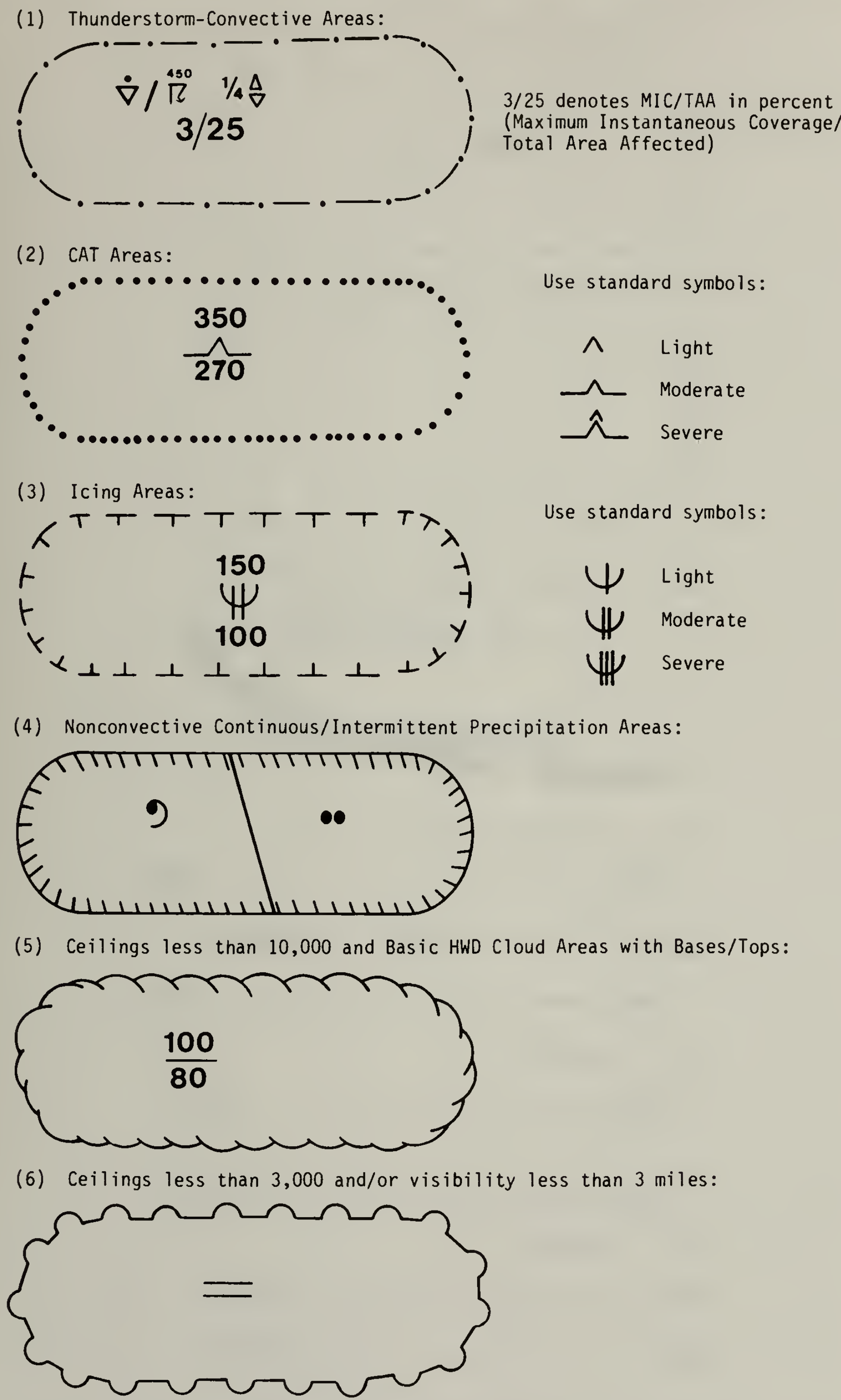
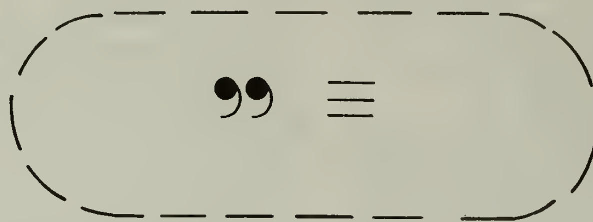


Figure XIV-3.—Weather feature outlines.

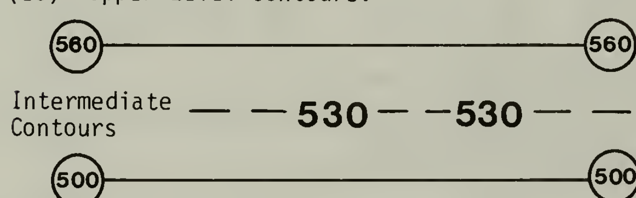
(7) Ceilings less than 1,000 and/or visibility less than 1 mile:



(8) Less than 2/8 Cloud Cover:

(9) Jet Stream, Maximum Wind Line:

(10) Upper Level Contours:



(11) Isotherms:

(12) Isotachs:

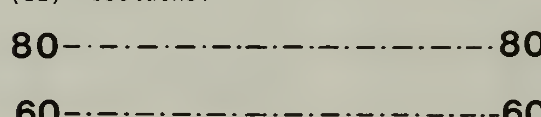


Figure AXIV-3.—Weather feature outlines—Continued.

APPENDIX XV

TIME ZONES

TIME ZONES

All naval personnel whose work brings them in contact with communications must have a thorough knowledge of the communication's use of time.

For reckoning time, the surface of the globe is divided into 24 zones, each bounded by meridians of 15° of arc, and each 1 hour of time apart in longitude. The initial time zone lies between 7 1/2°E and 7 1/2°W of the Greenwich (England) meridian. It is called ZONE ZERO because of the difference between the standard time of this zone and Greenwich civil time is zero. Each zone, in turn, is designated by the number which represents the difference between local zone time and Greenwich mean time (figure XV-1). In the vicinity of land, zones are modified to accord with the boundaries of the countries or the regions using corresponding time.

The zones lying in east longitude from zone zero are numbered 1 to 12 and are designated minus because for each of them the zone number is subtracted from the local time to obtain Greenwich mean time. The zones lying in west longitude from the zone zero are also numbered from 1 to 12, but are designated plus, since the zone number must be added to the local zone time to get GMT. The twelfth zone is divided medially by the 180th meridian, the minus half lying in east longitude and the plus half in west longitude. The number of a zone, prefixed by a plus or a minus sign, constitutes the zone description. In addition to the time zone number, each zone is also designated by the letters A through M (J omitted) corresponding to the minus zones, and the letters N through Y indicating the plus zones. (See top of figure XV-1.)

So that a standard time may be kept throughout the service, GMT is used to indicate the time of origin of most naval messages. This eliminates any doubt as to which time the originator is using. The designating letter for GMT is Z. However, the time of observation found in the text of coded weather messages is usually reported in GMT, so the designating letter Z is omitted in this case.

The approved method of expressing time in the 24-hour system is with the hours and minutes expressed as a 4-digit group. The first two figures of the group denote the hour; the second two the minutes. Thus, 6:30 a.m. becomes 0630 (cancelled ciphers are used in all naval messages to avoid confusion with the letter O); noon is 1200; and 6:30 p.m. is 1830. Midnight is expressed as 0000—not as 2400—and 1 minute past midnight becomes 0001. The time designation 1327Z indicates 27 minutes past 1:00 p.m., GMT. Numbers are prefixed to the time to indicate the day of the month; in other words, to form a date-time group (DTG). The DTG 171327Z means the 17th day of the current month plus the time in GMT. Dates from the first to the ninth of the month are preceded by the numeral 0.

Local time is sometimes used in the text of a message, but must be accompanied by the zone designating letter—as in the DTG 170812Q. If a local time is referred to frequently in the text, the suffix may be omitted, provided a covering expression, such as ALL TIMES QUEBEC, is used.

When it is necessary to indicate a date alone in a message, it is expressed by the day of the month, the 3-letter abbreviation of the month, and (if necessary) by the last two figures of the year: 3 FEB or 3 FEB 71. A night is expressed by the two dates over which it extends: NIGHT 3/4 FEB 71.

TIME CONVERSION TABLE

The time conversion table (Table XV-1) is useful for converting time in one zone to time in any other zone. Vertical columns indicate time zones. Zone Z is GMT. Time in each successive zone to the right of zone Z is 1 hour later, and to the left of zone Z is 1 hour earlier. Time in each successive shaded area to the right is 1 day (24 hours) later; to the left it is 1 day (24 hours) earlier.

To calculate time in zone U when it is 0500 hours in zone 1, for example, proceed as follows: find 0500 in column I and locate the time (1200) in the corresponding line in column U. Inasmuch as 1200 is not in the shaded area, the time is 1200 hours yesterday.

209.354

Figure XV-1.—Time zones of the world.

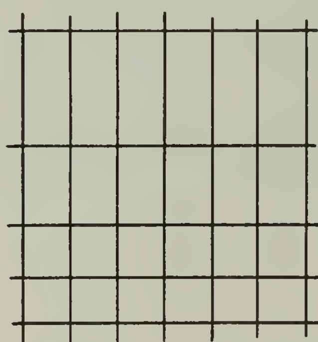
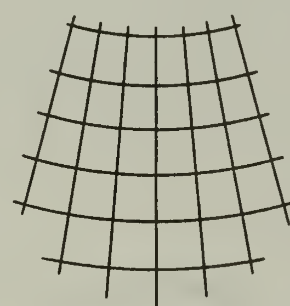
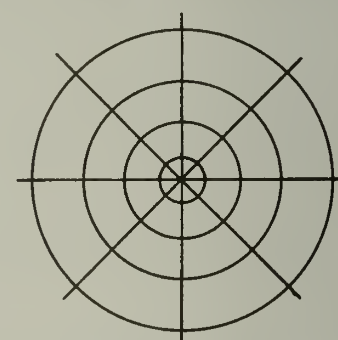
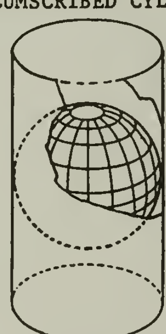
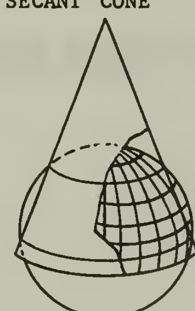
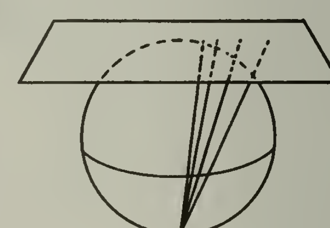
Table XV-1.—Time Conversion Table

PREVIOUS DAY	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	SAME DAY
	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	
	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	
	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	
	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	
	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	
SAME DAY	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	NEXT DAY
	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	
	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	
	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	
	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	
	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	
	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	
	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	
	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	
	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	
	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	
	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	
	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	
	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	
	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	
	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	
	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	
	Y	X	W	V	U	T	S	R	Q	P	0	N	Z	A	8	C	0	E	F	G	H	I	K	L	M	
	+12	+11	+10	+9	+8	+7	+6	+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	

209.439

APPENDIX XVI

MAP PROJECTIONS

	MERCATOR	LAMBERT CONFORMAL CONIC	POLAR STEREOGRAPHIC
PARALLEL	PARALLEL STRAIGHT LINES UNEQUALLY SPACED.	ARCS OF CONCENTRIC CIRCLES EQUALLY SPACED.	ARCS OF CONCENTRIC CIRCLES UNEQUALLY SPACED.
MERIDIAN	PARALLEL STRAIGHT LINES EQUALLY SPACED.	STRAIGHT LINES CONVERGING AT A POINT OUTSIDE OF MAP.	STRAIGHT LINES RADIATING FROM POLE.
APPEARANCE OF GRATICULE			
PROJECTED ON	CIRCUMSCRIBED CYLINDER 	SECANT CONE 	PLANE TANGENT AT POLE 
PROPERTIES	STRAIGHT LINES ARE RHUMB LINES. CONFORMAL. CONVENIENT PLOTTING. TRUE AREAS NOT SHOWN. STRAIGHT LINES NOT GREAT CIRCLES. TRUE DISTANCES NOT SHOWN. GREAT DISTORTION IN HIGH LATITUDES.	TRUE SHAPES. AREAS GOOD. DISTANCE GOOD. TRUE DIRECTIONS. SMALL NORTH-SOUTH LIMIT OF PROJECTION FOR ACCURACY. PLOTTING FAIR. NOT SATISFACTORY FOR AREAS CLOSE TO EQUATOR.	TRUE SHAPE. ONLY AZIMUTHAL PROJECTION WITH NO ANGULAR DISTORTION. TRUE AREAS NOT SHOWN. SCALE INCREASES IN ALL DIRECTIONS FROM CENTER.
USES	USED FOR AREAS CENTERED IN TROPICAL LATITUDES.	USED FOR AREAS CENTERED IN MIDDLE LATITUDES.	USED FOR NORTHERN AND SOUTHERN HEMISPHERE HIGH LATITUDES.

INDEX

D

R

S

T

V

W

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NONRESIDENT CAREER COURSE

AEROGRAPHER'S MATE THIRD CLASS

NAVEDTRA 10369

This self-study course is only one part of the total Navy training program. By its very nature it can take you only part of the way to a training goal. Practical experience, schools, selected reading, and YOUR desire to succeed are also necessary to round out a fully meaningful training program.

Your Nonresident Career Course (NRCC) contains a set of assignments and perforated answer sheets. If an errata sheet comes with the NRCC, make all indicated changes or corrections. Do not change or correct the Rate Training Manual (RTM) or assignments in any other way.

HOW TO COMPLETE THIS COURSE SUCCESSFULLY

You should read the RTM before taking the NRCC. Study the RTM pages given at the beginning of each assignment before trying to answer the questions. Pay attention to tables and illustrations as they contain a lot of information. Making your own drawings can help you understand the subject matter. You should read the learning objectives preceding each set of questions. The learning objectives and questions are based on the subject matter of the RTM. The learning objectives tell you what you should be able to do after studying the RTM. Answering the questions should help you accomplish the objectives.

At this point, you should be ready to answer the questions in the assignment. Read each question carefully. Select the BEST ANSWER for each question, consulting your RTM when necessary. Be sure to select the BEST ANSWER from the subject matter in the RTM. You may discuss difficult points in the course with others. However, the answer you select must be your own. Remove a perforated answer sheet from the back of the NRCC, write in the proper assignment number, and enter your answer for each question.

Your NRCC will be administered by your command or, in the case of small commands, by the Naval Education and Training Program Development Center. No matter who administers your course you can complete it successfully by earning a 3.2 for each assignment. The unit breakdown of the course, if any, is shown later under Naval Reserve Retirement Credit.

WHEN YOUR COURSE IS ADMINISTERED BY LOCAL COMMAND

As soon as you have finished an assignment, submit the completed answer sheet to the officer designated to grade it. The graded answer sheet will not be returned to you.

If you are completing this NRCC to become eligible to take the fleetwide advancement examination, follow a schedule that will enable you to complete all assignments in time. Your schedule should call for the completion of at least one assignment per month.

Although you complete the course successfully, the Naval Education and Training Program Development Center will not issue you a letter of satisfactory completion. Your command will make an entry in your service record, giving you credit for your work.

WHEN YOUR COURSE IS ADMINISTERED BY THE NAVAL EDUCATION AND TRAINING PROGRAM DEVELOPMENT CENTER

After finishing an assignment, go on to the next. Retain each completed answer sheet until you finish all the assignments in a unit (or in the course if it is not divided into units). Using the envelopes provided, mail your completed answer sheets to the Naval Education and Training Program Development Center where they will be graded and the score recorded. Make sure all blanks at the top of the answer sheet are filled in. Unless you furnish all the information required, it will be impossible to give you credit for your work. The graded answer sheets will not be returned.

The Naval Education and Training Program Development Center will issue a letter of satisfactory completion to certify successful completion of the course (or a creditable unit of the course). To receive a course-completion letter, follow the directions given on the course-completion form in the back of this NRCC.

You may keep the RTM and assignments for this course. Return them only in the event you disenroll from the course or otherwise fail to complete the course. Directions for returning the RTM and assignments are given on the course disenrollment-course completion form in the back of this NRCC.

PREPARING FOR YOUR ADVANCEMENT EXAMINATION

The *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*, NAVPERS 18068, lists by paygrade the minimum tasks you must be able to perform in your rating. These tasks are called occupational standards. Your examination for advancement is based on these occupational standards. The material used to prepare the questions for your advancement examination is listed in the *Bibliography for Advancement Examination Study*, NAVEDTRA 10052. For your convenience, the occupational standards and the bibliography for your rating are combined in a single booklet for the examinations given each year. These *Occupational Standards and Bibliography* booklets are available from your Educational Services Officer (ESO). Even though you have met the course requirement by successfully completing this NRCC, you should continue to study the RTM as you prepare for the advancement examination. Remember the RTM is one of the sources for advancement examination questions. Because the qualifications for your rating may have changed since your RTM was printed, you should refer to the latest annual edition of the rating *Occupational Standards and Bibliography* booklet.

NAVAL RESERVE RETIREMENT CREDIT

This course is evaluated at 18 Naval Reserve retirement points, which will be credited upon satisfactory completion of the entire course. Points for completion of each creditable unit will be assigned as follows:

Unit	Points	Assignment
1	12	1 through 6
2	6	7 through 9

These points are creditable to personnel eligible to receive them under current directives governing the retirement of Naval Reserve personnel.

COURSE OBJECTIVE

The objective of this course is to provide the Aerographer's Mate with information in the following areas: Operation and use of meteorological equipment; procedures for recording and taking surface and upper air observations; operational procedures for communications equipment; and upper air data; and the filing and displaying of weather data.

While working on this correspondence course, you may refer freely to the text. You may seek advice and instruction from others on problems arising in the course, but the solutions submitted must be the result of your own work and decisions. You are prohibited from referring to or copying the solutions of others, or giving completed solutions to anyone else taking the same course.

(U) Naval courses may include several types of questions—multiple-choice, true-false, matching, etc. The questions are not grouped by type but by subject matter. They are presented in the same general sequence as the textbook material upon which they are based. This presentation is designed to preserve continuity of thought, permitting step-by-step development of ideas. Not all courses use all of the types of questions available. The student can readily identify the type of each question, and the action required, by inspection of the samples given below.

MULTIPLE-CHOICE QUESTIONS (U)

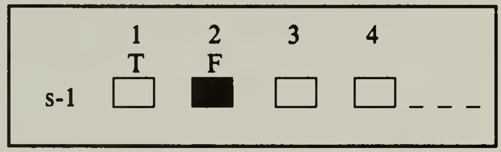
(U) Each question contains several alternatives, one of which provides the best answer to the question. Select the best alternative, and blacken the appropriate box on the answer sheet.

SAMPLE (U)

s-1. Who was the first person appointed Secretary of Defense under the National Security Act of 1947?

1. George Marshall
2. James Forrestal
3. Chester Nimitz
4. William Halsey

Indicate in this way on the answer sheet:



TRUE-FALSE QUESTIONS (U)

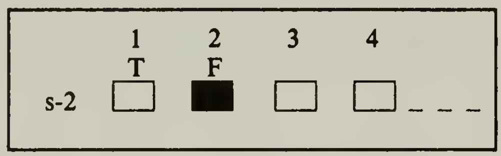
(U) Mark each statement true or false as indicated below. If any part of the statement is false the statement is to be considered false. Make the decision, and blacken the appropriate box on the answer sheet.

SAMPLE (U)

s-2. All naval officers are authorized to correspond officially with any systems command of the Department of the Navy without their respective commanding officer's endorsement.

1. True
2. False

Indicate in this way on the answer sheet:



MATCHING QUESTIONS (U)

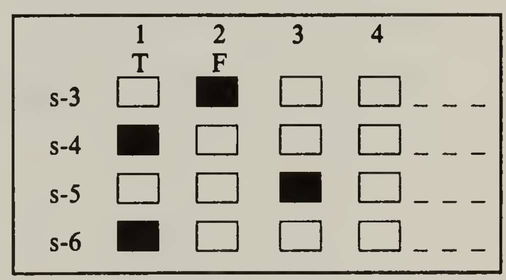
(U) Each set of questions consists of two columns, each listing words, phrases or sentences. The task is to select the item in column B which is the best match for the item in column A that is being considered. Items in column B may be used once, more than once, or not at all. Specific instructions are given with each set of questions. Select the numbers identifying the answers and blacken the appropriate boxes on the answer sheet.

SAMPLE (U)

(U) In questions s-3 through s-6, match the name of the shipboard officer in column A by selecting from column B the name of the department in which the officer functions. Some responses may be used once, more than once, or not at all.

A. OFFICER	B. DEPARTMENT
s-3. Damage Control Assistant	1. Operations Department
s-4. CIC Officer	2. Engineering Department
s-5. Disbursing Officer	3. Supply Department
s-6. Communications Officer	

Indicate in this way on the answer sheet:



Assignment 1

Sky Condition and Visibility

Textbook Assignment: Pages 1-1-1 through 1-1-67

In this course you will demonstrate that learning has taken place by correctly answering training items. The mere physical act of indicating a choice on an answer sheet is not in itself important; it is the mental achievement, in whatever form it may take, prior to the physical act that is important and toward which course learning objectives are directed. The selection of the correct choice for a course training item indicates that you have fulfilled, at least in part, the stated objective(s).

The accomplishment of certain objectives, for example, a physical act such as drafting a memo, cannot readily be determined by means of objective type course items; however, you can demonstrate by means of answers to training items that you have acquired the requisite knowledge to perform the physical act. The accomplishment of certain other learning objectives, for example, the mental acts of comparing, recognizing, evaluating, choosing, selecting, etc., may be readily demonstrated in a course by indicating the correct answers to training items.

The comprehensive objective for this course has already been given. It states the purpose of the course in terms of what you will be able to do as you complete the course.

The detailed objectives in each assignment state what you should accomplish as you progress through the course. They may appear singly or in clusters of closely related objectives, as appropriate; they are followed by items which will enable you to indicate your accomplishment.

All objectives in this course are learning objectives and items are teaching items. They point out important things, they assist in learning, and they should enable you to do a better job for the Navy.

This self-study course is only one part of the total Navy training program; by its very nature it can take you only part of the way to a training goal. Practical experience, schools, selected reading, and the desire to accomplish are also necessary to round out a fully meaningful training program.

Learning Objective: Identify the meteorological elements that relate to sky condition and visibility in preparing surface meteorological observations for transmission.

1-1. Variable visibility is entered in column 13 of the MF1-10 when the visibility is variable and is less than what maximum distance?
1. 1 mi
2. 2 mi
3. 3 mi
4. 4 mi

● Refer to table 1-1-1 in your textbook. In answering items 1-2 and 1-3, encode the cloud group 1C_L C_M C_H using the observed data.

1-2. C_L - 2, C_L - 3, C_M - 6
1. 1360
2. 136/
3. 1260
4. 126/

1-3. C_L - 1, C_L - 4, C_L - 9, C_H - 2, C_H - 3
1. 1493
2. 1423
3. 1903
4. 19/3

1-4. Obscuring phenomenon, such as haze, is considered as a layer when the haze
1. has an apparent base
2. has decreased the visibility to 6 miles
3. is below all other cloud layers
4. comes in contact with the surface

1-5. Ceiling heights are prefixed with an estimated (E) designator when all EXCEPT which of the following conditions occur?

1. When reported by a pilot within 1.5 miles of the runway and 15 minutes of the actual observation
2. When using a ceiling balloon for heights below the minimum height for VFR
3. When reporting cirriform layers within 50 miles and during the past hour preceding the observation
4. When reporting middle cloud layers within 25 miles and during the past 20 minutes preceding the observation

---

In items 1-6 through 1-9, select from column B the contraction which applies to each condition in column A.

	A. Summation amount of sky cover	B. Contractions
1-6.	10/10, more than half opaque	1. -X
		2. BKN
1-7.	6/10 through less than 10/10, more than half opaque	3. -SCT
		4. OVC
1-8.	1/10 to less than 10/10 surface-based obscuring phenomena	
1-9.	5/10 or less, half or more thin	

In items 1-10 through 1-13, select from column B the type of high cloud (C_H) that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. High Cloud Types
1-10.	Appears as small tufts or turrents and is referred to as a mackerel sky	1. C_H-2
		2. CH-4
		3. C_H-6
1-11.	CI or CS that extends to more than 45 degrees above the horizon and is without the sky being actually covered	4. CH-9
1-12.	CI in the form of hooks and/or filaments that progressively invades the sky	
1-13.	CI that is in patches or entangled sheaves which usually do not increase in size	

1-14. An indefinite ceiling used with the vertical visibility in a surface-based obscuring phenomenon is prefixed by

1. E
2. I
3. M
4. W

1-15. When reporting a variable ceiling, such as M18V BKN, what would be your entry in column 13?

1. CIG VARIABLE
2. CIG 14V22
3. CIG 14V22 BKN
4. CIG BKN 14V22

In items 1-16 through 1-21, select from column B the etage of the class of clouds listed in column A.

	A. Classes of Clouds	B. Etages
1-16.	Cumulonimbus	1. Low
1-17.	Nimbostratus	2. Middle
1-18.	Cirrocumulus	3. High
1-19.	Stratocumulus	
1-20.	Cirrostratus	
1-21.	Altocumulus	

1-22. Variable sky conditions are reported in column 13 when the cloud layer meets which, if any, of the following conditions?

1. The layer must be below 3,000 feet
2. The layer varies between 3 to 5 tenths
3. The layer varies between 6 to 9 tenths
4. None of the above

1-23. When you are reporting 8/10 of fog as a partly obscured condition and -X is entered in column 3 and in column 13, you must make what entry, if any?

1. FOG8
2. F8
3. 8FOG
4. None

1-24. When you are using the AN/GMQ-13 with a standard base line, the highest accurate value of the cloud height is approximately how many feet?

1. 4,000 ft
2. 8,000 ft
3. 15,000 ft
4. 20,000 ft

In items 1-25 through 1-28, select from column B the type of low cloud (CL) that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. Low Clouds
1-25.	CU and SC with bases at different levels	1. CL-3
		2. CL-4
1-26.	Very strong vertical development with no anvil present	3. CL-7
		4. CL-8
1-27.	Formed from the spreading out of CU or CB	
1-28.	Occurs below layers of AS and NS.	

1-29. Towering cumulus is considered a significant cloud and is reported in column 13. If you observed this cloud 10 miles northeast, what entry would be made?
1. 1200 10 NE
2. L-2 NE 10 MI
3. TCU NE 10 MI
4. TCU 10 NE

1-30. If the prevailing visibility is 1 mile, the visibility in the northeast section is 2 miles, in the southeast sector 1 mile, in the southwest sector 1/2 mile, and in the northwest sector 1/4 mile, what should be entered in column 13 of the MF1-10 form?
1. VSBY SW 1/2 NW 1/4
2. VSBY SE 1 SW 1/2 NW 1/4
3. VSBY NE 2 SW 1/2 NW 1/4
4. VSBY NE 2 SE 1 SW 1/2 NW 1/4

In items 1-31 through 1-34, select from column B the type of middle cloud (CM) that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. Middle Cloud Type
1-31.	Chaotic sky	1. CM-2
1-32.	Formed from the spreading out of CU or CB clouds	2. CM-6
		3. CM-7
1-33.	Two or more layers that do not progressively invade the sky	4. CM-9
1-34.	Often caused by a further thicking of dense AS	

1-35. When the sky condition using the METAR code is encoded, N_s indicates the amount of each individual layer and is entered to what nearest value?
1. Eighth
2. Eighth, shipboard only
3. Tenth
4. Tenth, shipboard only

1-36. The greatest visibility attained or surpassed throughout at least half of the horizon circle, NOT necessarily continuous, defines what visibility condition?
1. Prevailing visibility
2. Vertical visibility
3. Sector visibility
4. Horizontal visibility

1-37. Meteorologically speaking, obscuration of the sky would be caused by
1. an aurora
2. a single layer of clouds hiding the entire sky
3. several layers of clouds hiding the entire sky
4. surface-based smoke

In items 1-38 through 1-41, select from column B the contraction which applies to each condition in column A.

	A. Summation amount of sky cover	B. Contractions
1-38.	10/10, half or more thin	1. X
		2. SCT
1-39.	5/10 or less, more than half opaque	3. -BKN
1-40.	5/10 thru less than 10/10, half or more thin	4. -OVC
1-41.	10/10 surface-based obscuring phenomena	

1-42. If a cloud layer at 3,000 feet covers 6/10 of the sky and 3/10 of this sky cover is transparent, what is the sky cover termed?
1. Thin
2. Opaque
3. Transparent
4. Partial transparent

In items 1-43 through 1-46, select from column B the type of high cloud (C_H) that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. High Cloud Types
1-43.	CS which is not, or is no longer, progressively invading the sky	1. CH-3
		2. CH-5
1-44.	CI that is often in the form of an anvil or the remains of the upper parts of a CB	3. CH-7
		4. CH-8
1-45.	CS covering the celestial dome	
1-46.	CI or CS progressively invading the sky and generally growing more dense. The veil does not reach 45 degrees above the horizon	

1-47. Orographic clouds are formed as a result of air moving over rough terrain. This type cloud includes all EXCEPT which of the following clouds?
1. AC
2. CU
3. SC
4. ST

In items 1-48 through 1-51, select from column B the type of middle cloud (C_M) that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. Middle Class Types
1-48.	AC with sproutings in the form of small towers or battlements	1. CM-3
		2. CM-4
1-49.	AC in semitransparent bands or in one or more fairly continuous layers that progressively invade the sky	3. CM-5
		4. CM-8
1-50.	AC change slowly and are at the same level	
1-51.	AC in patches and continually change in appearance. Shaped as an almond	

1-52. Refer to table 1-1-3 of your textbook. In estimating the amount of an advancing cloud layer, it is determined that the angular elevation of the forward edge is 63 degrees and that of the rear edge is 27 degrees. What is the total sky cover?
1. 0.1
2. 0.2
3. 0.3
4. 0.4

In items 1-53 through 1-56, select from column B the type of low cloud (C_L) that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. Low Cloud Types
1-53.	Continuous sheet or layer and has no straulus fractus or bad weather	1. C_L-2
		2. C_L-5
		3. C_L-6
1-54.	Cirriform anvil is present	4. C_L-9
1-55.	Moderate or strong (towering) vertical development	
1-56.	SC formed by other than the spreading out of CU clouds	

1-57. Refer to table 1-1-4 of your textbook. If the observed ceiling value is 14,498 feet, how must it be reported?
1. 14,000 ft
2. 14,490 ft
3. 14,500 ft
4. 15,000 ft

1-58. An altocumulus cloud layer, even though attached to a cumulonimbus cloud layer, may be classified as a separate layer if the layer base levels meet which of the following criteria?
1. Thin
2. The same
3. Surface based
4. Different

In items 1-59 through 1-62, select from column B the cloud type that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. Cloud Types
1-59.	A mid-cloud that appears diffused, gray, and often dark, produces continuous precipitation	1. Stratus
		2. Nimbostratus
		3. Altostratus
1-60.	Appears white, gray, or a combination of white and gray. Virga is a common phenomenon	4. Altocumulus
1-61.	Consists primarily of ice crystals, snow crystals or flakes, and supercooled water droplets	
1-62.	Uniform appearance of the cloud base. Forms very close to the earth's surface	

1-63. Ceiling heights are prefixed with a measured (M) designator when the height is obtained by all EXCEPT which of the following methods?
1. AN/GMQ-13
2. Ceiling light
3. Isolated objects (towers) 2 miles or less from the runway
4. Balloon

1-64. Which of the following situations would be termed a ceiling?
1. A completely opaque "broken" cloud layer
2. A surface-based smoke obscuration of 9/10 of the sky
3. An "overcast" cloud layer with 6/10 classified as transparent
4. A layer of 5/10 cloud cover with bases at 1,500 feet

In items 1-65 through 1-67, select from column B the cloud type that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. Cloud Types
1-65.	Always has the "cottony" appearance	1. Stratocumulus
		2. Cumulus
1-66.	Produces the most intense storm known in weather (tornado)	3. Cumulonimbus
1-67.	Appears gray with dark areas and can merge into one layer	

1-68. The ceiling measurement that is used when the sky is totally obscured by smoke and haze is the vertical distance from the ground to the
1. top of the obscuration
2. bottom of the obscuration
3. highest point that can be seen vertically into the obscuration
4. base of the layer of clouds immediately above the obscuration

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In items 1-69 through 1-71, select from column B the cloud type that matches the cloud description listed in column A.

	A. Cloud Descriptions	B. Cloud Types
1-69.	A whitish veil-like appearance with a greater horizontal extent	1. Cirrus
		2. Cirrostratus
		3. Cirrocumulus
1-70.	Appears as very white clouds, usually in patches with a hook shape	
1-71.	Is often referred to as a mackerel sky	

Assignment 2

Weather and Obstruction to Vision

Textbook Assignment: Pages 1-2-1 through 1-2-26

Learning Objective: Identify the meteorological elements (relating to weather and obstruction to vision) and the procedures related to collecting, recording, and preparing surface meteorological observations for transmission.

2-1. Continuous precipitation is associated with which of the following cloud types?
1. SC
2. CU
3. CB
4. NS

2-2. A snow depth of 254 inches indicates which of the following coded 904 groups?
1. 90454 TWO
2. 904254
3. 90499 90499 90454
4. 90499 TWO 90454

2-3. Drifting snow and blowing snow are distinguished from each other by what primary difference?
1. Ten-knot difference in wind speed
2. Height above ground that particles are lifted
3. Visibility with blowing snow being greater
4. Size of the particles moved by the wind

2-4. Solid precipitation with a rounded white opaque appearance forming exclusively in convective clouds defines which of the following phenomena?
1. Snow
2. Snow pellets
3. Snow grains
4. Ice pellets

2-5. The tipping bucket and 4-inch plaster rain gage measures the amount of precipitation to the nearest
1. 0.01 in.
2. 0.02 in.
3. 0.05 in.
4. 0.10 in.

2-6. Which of the following statements gives the correct order of entry in column 5?
1. TORNADO, liquid precipitation, freezing precipitation, obstruction to vision
2. TORNADO, freezing precipitation, liquid precipitation, obstructions to vision
3. TORNADO, freezing precipitation, obstructions to vision, liquid precipitation
4. Freezing precipitation, liquid precipitation, obstructions to vision, TORNADO

2-7. All obstructions to vision are classified as what type(s)?
1. Hydrometer
2. Lithometeor
3. Both 1 and 2 above
4. Weather elements

In items 2-8 through 2-11, select from column B the METAR letter code, used in column 5A, which applies to each present weather description in column A.

	A. Present Weather Descriptions	B. METAR letter codes
2-8.	Light freezing rain	1. TSSA
2-9.	Heavy continuous drizzle	2. TSRASH
		3. FZRA-
2-10.	Thunderstorm with sandstorm	4. DZ+
2-11.	Thunderstorm with rain	

2-12. For observing purposes, a thunderstorm is considered present and occurring at your station for all EXCEPT which of the following situations?
1. When thunder is first heard
2. When lighting is observed
3. When hail is falling
4. When a tornado is observed

2-13. To be classified as a severe sandstorm, the blowing sand must decrease horizontal visibility to less than
1. 3/16 mi
2. 1/4 mi
3. 5/16 mi
4. 1/2 mi

In items 2-14 through 2-17, select from column B the METAR present weather code which applies to each present weather condition described in column A.

	A. Present Weather Conditions	B. Present Weather Codes
2-14.	Continuous moderate rain	1. 75XXSN
		2. 63RA
2-15.	Continuous heavy snow	3. 89GR
2-16.	Heavy rain showers	4. 82XXSH
2-17.	Hail	

2-18. Drizzle is frequently accompanied by low visibility and fog and it is associated with which of the following cloud types?
1. ST
2. SC
3. CU
4. CB

2-19. When the depth of ground fog is 5 feet, what information, if any, should be entered in colum 13?
1. GF 5FT
2. SHLW GF5
3. SHLW GFDEP 5
4. No entry is required

● Refer to Tables 1-2-1 through 1-2-4 in your textbook in answering items 2-20 through 2-23.

2-20. Which of the following intensities describes the rate-of-fall of precipitation (other than drizzle), when the rate is more than 0.01 inch to 0.03 inch in 6 minutes?
1. Light
2. Moderate
3. Heavy
4. Strong

2-21. Which of the following intensities describes the rate-of-fall of snow when visibility is equal to or less than 1/4 statute mile?
1. Light
2. Moderate
3. Heavy
4. Strong

2-22. Which of the following intensities describes the rate-of-fall of ice pellets when there is a slow accumulation?
1. Light
2. Moderate
3. Heavy
4. Strong

2-23. Which of the following intensities describes the rate-of-fall of rain when puddles form very rapidly?
1. Light
2. Moderate
3. Heavy
4. Strong

2-24. When you observe a tornado 2 miles south of your station (STL) and moving east, what entries, if any, are made for (a) column 5 and (b) column 13?
1. (a) TORNADO; (b) TORNADO 2S STL MOVG E
2. (a) TORNADO; (b) TORNADO MOVG E
3. (a) NONE; (b) TORNADO 2S STL MOVG E
4. (a) NONE; (b) TORNADO MOVG E

2-25. Which of the following statements on observing obstructions to vision is correct?
1. Cannot be considered as sky cover
2. Considered as sky cover when over station
3. Considered as sky cover when 0.1 or more and visibility is less than 7 miles
4. Considered as sky cover when 0.1 or more is observed

2-26. Which of the following compass directions is entered correctly for a column 13 entry when reporting a weather phenomenon from NE through S?
1. NE-S
2. NE-SE-S
3. NE-E-SE-S
4. S-NE

2-27. What form of precipitation is caused by supercooled water particles or when the precipitation comes in contact with a surface temperature below 32°F?
1. Solid
2. Liquid
3. Freezing
4. Ice pellets

2-28. Before an entry may be made in column 5 concerning blowing dust, what conditions must exist?
1. Vertical visibility restricted to less than 7 miles
2. Horizontal visibility restricted to less than 7 miles
3. The dust is at a depth of at least 6 feet
4. The dust is at a depth of at least 33 feet

In items 2-29 through 2-31, select from column B the type of precipitation that matches the precipitation description listed in column A.

	A. Precipitation Descriptions	B. Precipitation Types
2-29.	Changes intensity rapidly or begins and ends abruptly	1. Continuous
		2. Intermittent
2-30.	Increases or decreases gradually in intensity	3. Showery
		4. Mixture
2-31.	Increases or decreases gradually in intensity and stops and starts at least once within the hour	

2-32. All EXCEPT which of the following lithometeors are forms of obstructions to vision?
1. Blowing spray
2. Blowing dust
3. Blowing sand
4. Smoke

In items 2-33 through 2-36, select from column B the column number which applies to each statement in column A.

	A. Description of entries for METAR forms	B. Column Numbers
2-33.	RVR longline dissemination	1. 4A
		2. 4B
2-34.	METERS	
		3. 4C
2-35.	Statute miles	
		4. 4D
2-36.	RVR local dissemination	

2-37. The phenomenon, sometimes referred to as mist, composed of very small and uniformly dispersed droplets that appear to float in the air defines which of the following terms?
1. Rain
2. Drizzle
3. Dew
4. Snow

2-38. Ice fog consists of elements very similar to ice crystals EXCEPT that fog particles are suspended in the atmosphere. Ice fog usually forms below what minimum temperature?
1. 32°F
2. 0°F
3. -10°F
4. -20°F

2-39. When the whirling vortex beneath a cumulonimbus cloud descends to the surface over water, what storm phenomenon is occurring?
1. Tornado
2. Waterspout
3. Cyclone
4. Funnel cloud

2-40. To determine the presence of dust in the atmosphere, which of the following criteria may be used?
1. Look at distant objects to see if they appear tan or gray
2. Look at the sun's disk to see if it is pale
3. Look at the rays of the sun to see if they appear yellow
4. Each of the above

In items 2-41 through 2-44, select from column B the METAR column 13 entry which applies to each weather condition in column A.

	A. Weather Conditions		B. METAR column B Entries
2-41.	Variable ceiling	1.	OCNL LTGCCCG
2-42.	Variable visibility	2.	TCU SE
		3.	VIS 1/4V1/2
2-43.	Lightning		
		4.	CIGM012 CIG010V016
2-44.	Towering cumulus		

2-45. When the whirling vortex beneath a cumulonimbus cloud touches the ground, what storm phenomenon is occurring?
1. Tornado
2. Waterspout
3. Cyclone
4. Funnel cloud

2-46. When more than a trace of precipitation has occurred and the amount cannot be determined, what 24-hour precipitation coded data, if any, be entered?
1. 2////
2. 20000
3. /////
4. None

In items 2-47 through 2-50, select from column B the contraction which applies to each obstruction to vision in column A.

	A. Obstructions to vision		B. Contractions
2-47.	Blowing sand	1.	BY
2-48.	Blowing spray	2.	K
2-49.	Blowing snow	3.	BN
2-50.	Smoke	4.	BS

2-51. A severe thunderstorm (T+) entry in column 5 is required when which of the following conditions has occurred during the past 15 minutes?
1. Wind gusts of 55 knots and 5/8 inch hail
2. Wind gusts of 45 knots and 3/8 inch hail
3. Wind gusts of 45 knots and 5/8 inch hail
4. Wind gusts of 55 knots and 7/8 inch hail

2-52. All EXCEPT which of the following hydrometeors are forms of obstructions to vision?
1. Fog
2. Ground fog
3. Haze
4. Ice fog

In items 2-53 through 2-56, select from column B the contraction which applies to each weather phenomenon in column A.

	A. Weather Phenomenon		B. Contractions
2-53.	Thunderstorm	1.	A
2-54.	Hail	2.	T
2-55.	Snow showers	3.	ZR
2-56.	Freezing rain	4.	SW

2-57. All EXCEPT which of the following hydrometeors are forms of precipitation?
1. Snow
2. Dew
3. Ice pellets
4. Drizzle

2-58. During a tornado, funnel cloud, or waterspout activity, what cloud is always present?
1. CU
2. NS
3. CB
4. ST

● Use the following information for items 2-59 and 2-60:

Hail began at 38, ended at 50, and measured 1/2 inch in diameter.

2-59. What is the column 5 entry?
1. A -1/2 inch
2. A 1/2 inch
3. A
4. A+

2-60. What is the column 13 entry?
1. HAIL 1/2 INCH B38E50
2. A 1/2 INCH
3. AB38E50 1/2 HLSTO
4. AB38E50 HLSTO 1/2

2-61. For fog to be entered in column 5, the vertical depth of the fog must be more than what minimum amount?
1. Immediately above the observers head
2. 5 ft
3. 10 ft
4. 20 ft

2-62. At sea, blowing spray is reported when
1. visibility is 7 mi with a depth of 33 ft
2. visibility is 7 mi with a depth of 6 ft
3. visibility is 6 mi or less with a depth of 33 ft
4. visibility is 6 mi or less with a depth of 6 ft

2-63. What type of solid precipitation is associated with thunderstorm activity?
1. Hail
2. Ice pellets
3. Snow
4. Snow grains

2-64. Which of the following precipitation amounts is encoded correctly for appRR in column 13 for 1.08 inches of rain?
1. app08
2. app08 ONE
3. app108
4. app8 ONE

2-65. What is the primary difference between fog and ground fog?
1. Visibility must be lower in fog
2. Visibility must be higher in fog
3. Fog has a greater depth
4. The temperature/dew-point spread must be greater in fog

2-66. When the whirling vortex beneath a cumulonimbus cloud does NOT reach the ground, what storm phenomenon is occurring?
1. Tornado
2. Waterspout
3. Cyclone
4. Funnel cloud

● Use the following information for items 2-67 and 2-68:

A moderate thunderstorm began 52 minutes after the hour north of station and is moving northeast. A special observation was not transmitted by longline teletype.

2-67. Which of the following column 13 entries is correct for the special observation?
1. T N MOVG NE
2. T N MOVG NE (FIBI)
3. T MOVG NE (FIBI)
4. T B52 MOVG NE (FIBI)

2-68. Which of the following column 13 entries is correct for the record observation?
1. T B52 N MOVG NE
2. T B52 N MOVG NE (FIBI)
3. T N MOVG NE
4. MOD T N MOVG NE

2-69. What lithometeor causes the sun to appear red at sunrise and sunset and have an orange glow during the daytime?
1. Dust
2. Haze
3. Sand
4. Smoke

2-70. Which of the following 24-hour precipitation coded data is correct when 4.38 inches of rain has been measured?
1. 24438
2. 20044
3. 24380
4. 20438

2-71. The measuring tube inside the four-inch plastic rain gage is capable of visible precipitation measurements for a maximum of
1. 1 in.
2. 2 in.
3. 3 in.
4. 4 in.

2-72. Lightning is not considered as weather; however, each lightning remark in column 13 should contain all EXCEPT which of the following information?
1. Intensity
2. Frequency
3. Type
4. Direction from the station

2-73. Which, if any, of the following statements is a correct entry in column 5 for obstructions to vision?
1. Visibility must be 7 miles or less
2. Visibility must be less than 7 miles
3. Visibility has no effect on entries
4. None of the above

2-74. Which of the following GMT observation times requires a 904SpSp group to be encoded when more than a trace of snow is on the ground?
1. 0000
2. 0600
3. 1200
4. 1800

2-75. What term applies to liquid, freezing, on solid precipitation and water particles?
1. Hydrometerors
2. Lithometeors
3. Igneous meteors
4. Luminous meteors

Assignment 3

Pressure, Temperature, and Wind

Textbook Assignment: Pages 1-3-1 through 1-3-49

Learning Objective: Identify and classify criteria and techniques for reporting individual elements of the surface observation report.

3-1. With a peak wind of 38 knots and a direction of 245 degrees occurring at 1118 GMT, what entry is made in column 13?
1. PK WND 245-38/1118
2. PK WND 24-38/18
3. PK WND 2538/18
4. PK WND 2438/18

3-2. A rotor psychrometer differs from a sling psychrometer in that the rotor psychrometer
1. is operated within the instrument shelter
2. consists of two separate thermometers
3. contains a wick which must be moistened with distilled water before use
4. is used to obtain data to enter a table to calculate relative humidity

3-3. Which of the following statements concerning the table of "r" values is correct?
1. An "r" table may be used at all stations
2. The values found in the "r" table are a ratio of station pressure to temperature
3. By algebraically adding the appropriate value from the "r" table to sea level pressure, station pressure may be computed
4. The table is used in conjunction with the meteorological computer, CP-402/UM, for the determination of sea level pressure

3-4. When you enter the dry-bulb and dew-point temperature on the CNOC 3140/7 form, the values are entered to the nearest
1. tenth degree fahrenheit
2. whole degree fahrenheit
3. tenth degree celsius
4. whole degree celsius

3-5. The operation of the standard air thermometer depends upon the
1. similarity of the coefficients of expansion of glass and air
2. similarity of the coefficients of expansion of glass and alcohol or mercury
3. difference between the coefficients of expansion of air and alcohol or mercury
4. difference between the coefficients of expansion of glass and mercury or alcohol

3-6. The pitch, roll, and vibration of the ship can cause excessive variations from the true reading on the marine barograph. What part of the pen shaft assembly helps to prevent these variations? variations?
1. The damping cylinder
2. The case mounting
3. The range adjustment
4. The linearity adjustment

3-7. Which of the following statements describes the AN/GMQ-29 display of the wind direction and wind speed?
1. Direction in whole degrees; speed in whole MPH
2. Direction in whole degrees; speed in whole knots
3. Direction in tens of degrees; speed in whole MPH
4. Direction in tens of degrees; speed in whole knots

3-8. What unit is employed in the ML-448/UM barometer to detect variations in atmospheric pressure?
1. Alcohol cistern
2. Sylphon cell
3. Mercury cistern
4. Liquid cylinders

3-9. When reading the dry-bulb and wet-bulb thermometers from a psychrometer, the temperature values are read to the nearest
1. 0.1 degree
2. 0.2 degree
3. 0.5 degree
4. 1.0 degree

3-10. When you report a squall in a surface observation, what entry is required in column 11?
1. B
2. G
3. Q
4. S

3-11. Barometric pressure is displayed on the AN/GMQ-29 to the nearest
1. 0.1 mb
2. 0.01 mb
3. 0.2 mb
4. 0.5 mb

3-12. The Density Altitude Computer CP-718/UM, although primarily designed to determine atmospheric density, can also be used to determine
1. vapor pressure and specific humidity
2. vapor pressure and "r" factors
3. specific humidity and "r" factors
4. specific humidity and station pressure

3-13. Which of the following statements defines surface wind direction?
1. It is the average direction toward which the wind blows for 1 minute
2. It depends on the orientation of the runways
3. Direction is given as the point toward which the wind is heading
4. Direction is given as the point from which the wind is coming

3-14. Which of the following statements describes the type B3 shipboard wind system?
1. Indicator gives apparent wind direction
2. Indicator gives apparent wind speed
3. Both 1 and 2 above
4. Indicator gives true wind data

In items 3-15 through 3-18, select from column B the term which applies to each definition in column A.

	A. Definitions	B. Terms
3-15.	The pressure exerted by the atmosphere at a given point	1. Atmospheric pressure
3-16.	The atmospheric pressure at the assigned station elevation	2. Station pressure
3-17.	The height above sea level to which station pressure pertains	3. Station elevation
3-18.	A pressure value obtained by the theoretical reduction of station pressure to sea level	4. Sea level pressure

3-19. What equipment is used as a backup system for the AN/GMQ-29 when wind direction and speed is obtained?
1. AN/GMD-1
2. AN/GMD-2
3. AN/SMQ-1
4. AN/PMQ-3

3-20. To ventilate the sling psychrometer, the minimum speed of the air passing over the bulbs should be how many feet per second?
1. 2
2. 5
3. 10
4. 15

3-21. What is the range of the standard air thermometer used by the Naval Weather Service?
1. 0°F to +140°F
2. +20°F to +120°F
3. -10°F to +110°F
4. -20°F to +120°F

3-22. Wind chill equivalent temperature is a result of cooling by wind. The effects of wind chill are most noticeable on which of the following objects?
1. Exposed flesh
2. Water on runways
3. Aircraft
4. Ships operating in cold water

3-23. If the altimeter setting of a station was determined to be 29.97 inches from pressure instruments NOT periodically checked with a mercurial barometer, how is this information to be entered in column 12 of an CNOC 3140.7 form?
1. 997E
2. E997
3. E99.7
4. 99.7E

3-24. Along with wind direction and wind speed, the AN/GMQ-29 recorder also provides information on what other factors?
1. GUSTS
2. SQUALLS
3. Both 1 and 2 above
4. Pressure differentials

In items 3-25 through 3-28, select from column B the term which applies to each definition in column A.

A. Definitions	B. Terms
3-25. The net difference between the barometic pressure at the beginning and end of a specified interval of time	1. Pressure change
	2. Pressure characteristic
3-26. The pressure characteristic and amount of pressure change during a specified period of time	3. Pressure tendency
	4. Pressure altitude
3-27. The indicated altitude of a pressure altimeter at an altitude setting of 29.92 inches of mercury	
3-28. The pattern of the pressure change as indicated by a barograph trace	

3-29. Which of the following statements describes the requirements for entering a peak wind speed?
1. When the wind speed exceeds the average wind speed for the last hour
2. When a recorded wind speed exceeds 25 knots since the last record observation and the speed was not included in the body of a special observation transmitted on longline teletype
3. Anytime the wind speed exceeds 25 knots
4. It is entered only on synoptic observations

3-30. The correct procedures for filling in surface observations form (CNOC 3140.7) can be found in which of the following publications?
1. FMH-1
2. FMH-2
3. FMH-3
4. FMH-4

3-31. For a minimum thermometer, the lowest temperature reached during any time period is recorded by what unique feature?
1. A constriction in the thermometer's bore prevents the alcohol from rising again
2. A dumbell shaped index descends with the alcohol and its weight prevents it from rising when the temperature increases
3. The alcohol drops into a bowl as the temperature decreases and the remaining alcohol can't rise with increased temperature
4. The bore is divided into separate chambers that cover different temperature ranges

3-32. When rapidly falling pressure has been observed, an appropriate entry is made on CNOC 3140.7 in what column?
1. 6
2. 12
3. 13
4. 17

3-33. When a sample of air is saturated at a temperature of 52°F, what is the reading of the sample's dewpoint?
1. Exactly 52°F
2. Between 45° and 52°F
3. Between 52° and 59°F
4. 60°F or above

3-34. When you are immersed in sea water, your body loses heat to the water by conduction. The rate of the heat loss depends primarily on the
1. surface wind speed
2. water current speed
3. temperature of the water
4. rate the person moves about

3-35. When you record the surface wind direction on the CNOC 3140/7 and the wind speed is 100 knots or more, what must be done to the coded wind direction?
1. Enter as it is
2. Enter as it is and enter 100 knots in column 13
3. Add 50 to the direction
4. Add 180 to the direction

3-36. When you use the electric psychrometer, in which of the following cases can you record a reliable temperature?
1. When the wet-bulb temperature stabilizes at a minimum value
2. When the wet-bulb temperature equals the dry-bulb temperature
3. When the wet-bulb temperature is less than the dry-bulb temperature
4. When the wet-bulb temperature is more than the dry-bulb temperature

3-37. When the roll of a ship causes the indicator on the aneroid barometer to oscillate, how, if at all, should the observer obtain the station pressure?
1. By taking the higher pressure position on the indicator
2. By taking the mean pressure position on the indicator
3. By taking the lower pressure position on the indicator
4. No pressure reading should be taken

3-38. Which of the following statements regarding the electric psychrometer is NOT a correct operating procedure?
1. Position the air intake into the wind
2. Position the air intake so that it is entirely free of obstructions
3. Hold the instrument close to operator's body for easy and accurate reading
4. The exhaust ports must be entirely free of obstructions

3-39. A sea level pressure of 987.3 mb is entered in column 6 on CNOC 3140.7 in what format?
1. 987.3
2. 987
3. 873
4. 87.3

In items 3-40 through 3-43, select from column B the term which applies to each definition in column A.

	A. Definitions	B. Terms
3-40.	A fall in station pressure at the rate of 0.06 inches or more per hour	1. Altimeter setting
3-41.	The pressure altitude corrected for temperature deviations from the standard atmosphere	2. Density altitude
3-42.	The highest point on any of the runways of the airfield above mean sea level	3. Pressure falling rapidly
3-43.	The pressure value used to set the aircraft altimeter	4. Field elevation

3-44. As a back-up to the AN/GMQ-29, the rotor and sling psychrometers are used to obtain temperature data. Along with the dry-bulb temperature, what other data can be taken directly from the psychrometers?
1. Dew-point temperature
2. Wet-bulb temperature
3. Relative humidity
4. Freezing temperature

3-45. What type of batteries are used in the ML-450A/UM?
1. Size D, dry cell
2. Size C, dry cell
3. Size A, dry cell
4. Size A, water activated

3-46. Which of the following statements describes what takes place between dry-bulb and wet-bulb temperatures during a condition of dense fog?
1. Both have the same values
2. The wet-bulb temperature is always lower
3. The wet-bulb temperature is always higher
4. The dry-bulb temperature always increases

3-47. The two thermometers of the ML-450A/UM have a temperature range of
1. -10°F to +100°F
2. + 0°F to +110°F
3. +10°F to +120°F
4. +10°F to +110°F

3-48. Which of the following statements describes the correct position of the max/min thermometers in the Townsend support?
1. Max 5° below/min 5° above
2. Max 5° above/min 5° below
3. Max/min level
4. Max/min 90°

3-49. A marine barograph is often referred to as a microbarograph because of its
1. reduced scale, high sensitivity, and remote recording features
2. high sensitivity, magnified scale, and accurate temperature compensation
3. magnified scale, widely calibrated range, and precision maintenance ability
4. widely calibrated range, accurate temperature compensation, and remote recording features

3-50. Before you ventilate the psychrometer, you find the temperature is below freezing. When should you moisten the wet-bulb wick?
1. Just prior to operating
2. 5 minutes before operating
3. 10 minutes before operating
4. 15 minutes before operating

3-51. Accuracy is most important when you read the air thermometer. Due to parallax, if your eye is too low when you read the values, how, if at all, is the reading affected?
1. The reading is higher than the actual temperature
2. The reading is lower than the actual temperature
3. You are unable to take any reading
4. There is no effect

3-52. Which of the following statements describes the entry in column 13 of a variable wind direction?
1. WND 32V05
2. WND VAR
3. WND 36 VAR
4. WND VAR 36

3-53. Temperature, defined as the measure of an item's molecular activity, is measured on an arbitrary scale from that point at which the molecules of that item stop moving. This point is known as
1. absolute zero
2. the item's boiling point
3. the item's freezing point
4. zero on whatever thermometer is being used

3-54. The 24-hour past minimum temperature is encoded in column 13 for the observation taken at what time?
1. 0000 GMT
2. 0600 GMT
3. 1200 GMT
4. 1800 GMT

3-55. The net pressure change in a specified time and the characteristics of the change during that specified time are generally determined at stations equipped with a/an
1. CP-402/UM
2. AN/GMQ-29
3. microbarograph
4. hygrothermograph

3-56. All wind observations are made in terms of wind
1. direction only
2. velocity only
3. direction and velocity
4. average

3-57. The precision aneroid barometer (ML-448/UM) is constructed to indicate atmosphere pressure in what measurements?
1. Millibars
2. Inches of mercury
3. Both 1 and 2 above
4. Dynes

3-58. Which of the following statements defines a squall?
1. A sudden increase in wind speed of at least 15 knots and sustained at 20 knots or more for at least 1 minute
2. A sudden increase in wind speed of at least 25 knots and sustained at 45 knots or more for at least 1 minute
3. A sudden increase in wind speed of 30 knots or more for less than 1 minute
4. A sudden increase in wind speed of 10 knots or more from last recorded wind speed

3-59. When a sling psychrometer is used, the operator must whirl it several times, read both thermometers to the nearest tenth of a degree, and repeat the whirling until the wet-bulb temperature fails to show further decline. The difference between the dry-bulb and wet-bulb temperature is known as the
1. absolute humidity
2. wet-bulb depression
3. relative humidity
4. dewpoint

3-60. The overall effect of excessive heat on the body is known as heat stress. Which of the following factors contributes to heat stress?
1. Low temperature
2. Bright lights
3. Low humidity
4. Low winds during high humidity

3-61. If you visually read the ML-448/UM barometer and your reading is higher or lower than the correct reading, the problem is caused by the angle of
1. incidence
2. reflection
3. refocus
4. parallax

3-62. To compute the relative humidity using the psychrometric computer CP-165/UM, you must know what values?
1. Dry-bulb and wet-bulb readings
2. Dry-bulb reading and dew-point depression
3. Dry-bulb reading and dew-point
4. Wet-bulb reading and dew-point

3-63. Wind direction and wind speed are displayed on the readout panel of the AN/GMQ-29 through a very complex electronic system. How often is this display updated?
1. Every 14 sec
2. Every 30 sec
3. Every 45 sec
4. Every 60 sec

3-64. What thermometer has a constriction in the bore?
1. Standard
2. Minimum
3. Maximum
4. Rotor

3-65. When the air is not in motion, the wind condition is said to be
1. slow
2. calm
3. wavering
4. smooth

3-66. Which of the following procedures describes the sequence used to read and reset the maximum and minimum thermometers?
1. Read max; read min; reset max; reset min
2. Read max; reset max; read min; reset min
3. Read min; reset min; read max; reset max
4. Read min; read max; reset max; reset min

3-67. The AN/PMQ-3 anemometer has two wind scales. The low scale ranges from 0 to 15 knots and the high scale has what range?
1. 0-60 kn
2. 15-60 kn
3. 0-75 kn
4. 15-75 kn

3-68. An altimeter setting of 29.15 inches is entered in column 12 on CNOC 3140.7 as what value?
1. 29.15
2. 2915
3. 9.15
4. 915

3-69. A station pressure of 29.140 inches is entered in column 17 on CNOC 3140.7 as what value?
1. 29140
2. 29.140
3. 9140
4. 9.140

3-70. If the temperature is above freezing and you need to ventilate the psychrometer, when should you moisten the wet-bulb wick?
1. Before taking the psychrometer outside
2. Just prior to ventilating
3. 15 minutes before operating
4. 20 minutes before operating

3-71. You are entering the wind summary of the day on CNOC 3140/7, columns 71, 72, and 73, and more than two peak winds with the same speed have occurred. In what column(s), if any, will the additional occurrences be entered?
1. 13
2. 71 and 72
3. 90
4. None

3-72. Altimeter settings are computed for all observations EXCEPT for what type of observations?
1. Single element special observations
2. Special observations
3. Local observations
4. Record special observations

3-73. The AN/GMQ-29 display unit gives digital readouts for all EXCEPT which of the following data?
1. Temperature
2. Dew-point
3. Dew-point depression
4. Maximum temperature

3-74. Aboard ship, the wind direction is observed in relation to
1. the ship's bow
2. the ship's stern
3. true north
4. magnetic north

3-75. The apparent or relative wind speed and direction, minus the affect of the ship's speed and direction, is the true wind speed and direction. Which of the following equipment is NOT used in computing shipboard wind?
1. CP-264/U computer
2. Maneuvering board
3. Plotting board
4. AN/GMD-1

Assignment 4

Types of Surface Observations; Surf Observations

Textbook Assignment: Pages 1-4-1 through 2-1-11

Learning Objective: Identify and classify criteria and techniques used for reporting record, special, and local observations; obtain marine portions of surface observations; and record pilot reports.

4-1. The flight altitude (32,000 ft) of an aircraft is reported on the PIREP form in what format?
1. FL 320
2. FL320
3. FL 32000
4. FL32000

4-2. As an observer, you have just received freezing level data from the upperair section. Which of the following statements describes the procedure you are to follow?
1. The data is entered in column 13 of the next observation following receipt
2. The data is entered in column 13 of the first record observation following receipt
3. The data is entered in column 90 with the time (GMT) of receipt
4. The data is transmitted, but is not entered on the observation form

4-3. Which of the following statements describes the difference between a sea wave and a swell wave?
1. A sea wave is 1 foot higher than a swell wave
2. A sea wave is 3 to 5 feet higher than a swell wave
3. A sea wave has a direction at least 30° greater than a swell wave
4. A sea wave has a direction 30° less than a swell wave

4-4. What time (GMT) would most likely be used to record the time of a record observation?
1. 1105
2. 1358
3. 1840
4. 2101

4-5. A local observation is required immediately following notification of an aircraft mishap at or near the station. The observation consist of all elements normally included in a record observation, except sealevel pressure. How is this incident reported in the remarks section of the observation report?
1. ACFT EMGCY
2. ACFT ACCIDENT
3. ACFT EMGCY on RNWY
4. ACFT MISHAP

4-6. Which of the following temperatures is a correct entry for a METAR observation?
1. 10°F
2. M10°F
3. 12°C
4. M12°C

● In items 4-7 through 4-10, refer to the following RADAT data.

RADAT 98M019029051/1

4-7. What is the relative humidity reported?
1. 19
2. 51
3. 98
4. Missing

4-8. The relative humidity reported is reported for what level?
1. Low
2. Middle
3. High

4-9. What is the height of the first level?
1. 190 ft
2. 290 ft
3. 1900 ft
4. 2900 ft

4-10. The /1 at the end of the RADAT data indicates what information?
1. Only one level had humidity
2. The first level includes the humidity
3. The humidity is the same for all levels except one
4. The number of crossings of the freezing level other than the heights encoded

4-11. Sea waves are generated by
1. local surface winds
2. surface winds outside local area
3. long swell waves
4. short swell waves

4-12. Which of the following PIREP data is NOT used as criteria for transmitting a PIREP via longtime teletype?
1. Light turbulence
2. Severe turbulence
3. Severe icing
4. Funnel clouds

4-13. Local observations may be taken and recorded at any weather observing station. They are taken primarily to report changes in conditions that are significant to
1. base commander
2. local operators
3. public works departments
4. emergency vehicles

4-14. Which of the following METAR wind entries is NOT correct for the recording of maximum wind speed?
1. 270° 3/9 kn
2. 270° 12/20 kn
3. 270° 33/48 kn
4. 270° 110/130 kn

4-15. Which of the following items is NOT included in a PIREP report?
1. Closed bases and tops
2. Wind direction and speed
3. Icing levels
4. Altimeter settings

In items 4-16 through 4-19, select from column B the wave term which applies to each description in column A.

	A. Descriptions	B. Wave Terms
4-16.	The vertical distance between the level of the crest and the level of the trough	1. Crest
		2. Trough
		3. Period
4-17.	The top of a wave	4. Height
4-18.	The interval in seconds between the passage of two successive crests of well-formed waves past a fixed point	
4-19.	The bottom of a wave	

4-20. Which of the following statements describes the correct entry of a wind direction of 340 degrees and 142 knots on a PIREP form?
1. 84042
2. 34142
3. 34042 ONE
4. 340142

4-21. Which of the following times (GMT) is NOT considered a 3-hour report?
1. 0100
2. 0300
3. 0900
4. 1500

4-22. Which of the following statements describes the temperature entries on a PIREP form?
1. Whole degrees Fahrenheit
2. Tenth of a degree Fahrenheit
3. Whole degrees Celsius
4. Tenth of a degree Celsius

4-23. Which of the following factors is NOT a criteria for taking a special observation?
1. Windshift
2. Temperature drop of 20°
3. Runway visual range
4. Sky condition

4-24. Which of the following criteria is NOT a requirement for a special observation for precipitation?
1. Hail ends
2. Freezing precipitation changes intensity
3. Snow showers beginning while continuous snow was occurring
4. Ice pellets ends

4-25. Which of the following message type indicators is used to report a severe PIREP report?
1. UA
2. UUA
3. SEV-PIREP
4. SP

4-26. Which of the following column 3 entries meets a special observation for a ceiling change?
1. M1500 increasing to M1800 ft
2. M1800 decreasing to M1500 ft
3. M1200 increasing to M1400 ft
4. M1400 increasing to M1500 ft

4-27. Which of the following statements describes what is meant by freezing level data encoded as RADAT ZERO?
1. RADAT is missing
2. Entire sounding is warmer than zero
3. Entire sounding is colder than zero
4. Entire sounding is colder than 40 below zero

4-28. Which of the following data is NOT part of the message type indicator 10V?
1. Position
2. Time
3. Air speed
4. Altitude

4-29. Which of the following criteria is NOT a requirement for a special observation for a tornado?
1. Reported by a Scoutmaster 35 minutes ago
2. Reported by the state police 1 hour ago
3. Observed at station
4. Disappears from sight at station

4-30. Which of the following criteria is NOT a requirement for a special observation for thunderstorms?
1. Decreases in intensity
2. Begins
3. Increases in intensity
4. Ends

4-31. Which of the following sky cover data is entered correctly on a PIREP form when the sky was reported as broken, the bases at 12,000 feet, and the tops at 22,000 feet?
1. BKN 120/220
2. 120 BKN 220
3. 120/220 BKN
4. A120 BKN 220

1. A 3-hour barometric change
2. A 3-hour barometric change/the amount of precipitation
3. Cloud group (when clouds are present)
4. 904 group (when snow occurs)
5. Max/min temperature (when required)
6. 24-hour precipitation

Figure 4-A

● In items 4-32 and 4-33, refer to figure 4-A which lists column 13 entries.

4-32. What groups are included in a 3-hour report?
1. 1 and 3 only
2. 1, 3, and 5
3. 2 and 3 only
4. 2, 3, and 5

4-33. What groups are included in a 6-hourly report?
1. 1, 3, 4
2. 2, 3, and 4 only
3. 2, 3, 5, and 6 only
4. 2, 3, 4, 5, 6

4-34. A special observation is required when the prevailing visibility decreases to less than, or, if below, increases to equal or exceeds which of the following visibility values?
1. 1 1/2 mi
2. 1 1/8 mi
3. 3/8 mi
4. 1/3 mi

4-35. When referring to the direction of sea and swell waves, the wave's direction is determined by the
1. point toward which the wave is going
2. point from which the wave is coming
3. direction of the ship's head plus 90°
4. direction of the ship's head minus 90°

4-36. Which of the following turbulence (/TB) data is a part of the PIREP report?
1. Intensity
2. Type
3. Altitude
4. All of the above

Learning Objective: Recognize the principles and procedures used for observing and reporting surf conditions.

4-37. Which of the following terms is NOT described as a breaker?
1. Spilling
2. Backwash
3. Plunging
4. Surging

In items 4-38 through 4-41, select from column B the coded prefix which applies to the description in column A.

	A. Descriptions	B. Coded Prefixes
4-38.	The height of the highest breaker observed	1. ALFA
		2. BRAVO
4-39.	The percentage of breakers by type	3. CHARLIE
		4. DELTA
4-40.	The breaker period	
4-41.	The height of the average of the highest one-third of the breakers observed	

4-42. Which of the following items of information is NOT a required entry in the remarks (HOTEL) portion of the SURFOB worksheet?
1. Significant factors affecting boat operations
2. Thunderstorms
3. Secondary breaker system
4. Low clouds

4-43. Which of the following information is NOT part of the SUROB report heading?
1. Person's name taking the observation
2. Sequential number
3. Beach name
4. Date and time

4-44. ECHO is entered on the SURFOB worksheet as the angle the breaker makes with the
1. observer
2. beach
3. coastline
4. approaching landing craft

4-45. To determine the littoral currents (FOXTROT) for entry on the SURFOB worksheet, you should throw an object that floats into the water in front of the innermost breaker and
1. pace off the distance in feet that the object travels along the shoreline in 1 minute
2. pace off the distance in feet that the object travels along the shoreline in 10 minutes
3. time how long it takes to move 100 feet along the shoreline
4. estimate its speed with a special instrument

4-46. Which of the following SURFOB data is included in the wave height observation portion of the worksheet?
1. Time you began observing
2. Time you ended observing
3. Both 1 and 2 above
4. Total time of observation

In items 4-47 through 4-49, select from column B the breaker term which applies to the description in column A.

	A. Descriptions	B. Breaker Terms
4-47.	The breaker starts at scattered points along the wave; then joins the wave until the wave becomes an advancing line of foam.	1. White water 2. Spilling 3. Plunging 4. Surging
4-48.	The breaker is characterized by a loud explosive sound.	
4-49.	The breaker surges up the beach face as a wall of water that may or may not be white water	

4-50. Which of the following statements describes the procedure used to determine the data for the surf zone (GOLF) for recording on the SURFOB worksheet?

1. Count the number of breaker lines and estimate the width
2. Count the number of breaker lines and measure the width by using an incoming landing craft
3. Start with the outermost breaker and count the number of breaker lines, then estimate the width
4. Start with the outermost breaker and count the number of breaker lines; then multiply the number of lines by the average height of the breakers

4-51. Which of the following breaker code letters is NOT a reportable letter used in the wave height observation portion of the SURFOB worksheet?

1. e
2. p
3. s
4. x

4-52. Wave height observations are necessary before the code groups ALFA through DELTA are billed in on the surf observation report. How many successive waves must be observed and entered on the worksheet?

1. 25
2. 50
3. 75
4. 100

Assignment 5

Upper Air Observations; Winds Aloft Observations; Surface Synoptic Reports

Textbook Assignment: Pages 2-2-1 through 3-1-12

Learning Objective: Identify the basic procedures for collecting, recording, and preparing for transmission of upper air observations.

5-1. Which of the following statements describes what the adiabatic charts (MF3-31s) depict after all of the required computations have been completed?
1. Weather for the last 6 hours
2. Weather for the last 12 hours
3. Vertical profile of the upper atmosphere above the station
4. Forecast vertical profile of the upper atmosphere above the station

5-2. Which of the following times is NOT a valid release time for a radiosonde scheduled observation?
1. 1700 GMT
2. 1730 GMT
3. 1800 GMT
4. 1830 GMT

5-3. Which of the following functions is NOT a purpose of the adiabatic charts (MF3-31s)?
1. Analyzing
2. Recording
3. Graphing
4. Coding

5-4. Which of the following data on the adiabatic charts (MF3-31s) is NOT taken from the recorder record?
1. Pressure contact
2. Wind data
3. Temperature ordinate
4. Humidity ordinate

5-5. To avoid damaging the transmitter circuit of a radiosonde transmitter, install the antenna before you perform which of the following functions?
1. Visually check the transmitter
2. Handle the transmitter
3. Install the hygristor
4. Connect the battery

5-6. When setting the humidity evaluator, rotate the humidity disk until the humidity value of 33 percent is under the cursor line. The cursor line indicates what temperature?
1. Outside air
2. Wet-bulb
3. 25°C
4. 30°C

5-7. Above the surface level, every level selected on the recorder record will have all of the following data entered on it EXCEPT which one?
1. Time
2. Pressure contact
3. Humidity in percent
4. Temperature ordinate value

5-8. Before releasing a radiosonde balloon and train you are required to obtain authorization from what activity or person(s)?
1. Officer in charge
2. Air control personnel
3. Public works department
4. Operations division officer

5-9. The reason for termination of the sounding is entered within the station's identification data stamp. The reason for this termination is also entered at what other location?
1. At the top of the recorder record
2. Slightly above the last ascent level evaluated
3. Slightly below the last ascent level evaluated
4. 1-inch below the top of the recorder record

5-10. The procedures for checking the voltages used with the VIZ ACCU-LOK transmitter are found in which of the following FMHs?
1. 5
2. 6
3. 3
4. 4

5-11. The word ordinate is NOT associated with which of the following terms?
1. Temperature ordinate
2. Humidity ordinate
3. Dew-point ordinate
4. Chart division

5-12. Levels are placed on the recorder record for all EXCEPT which of the following reasons?
1. Mandatory pressure levels
2. Significant time levels
3. Temperature significant levels
4. Additional levels

5-13. To enter the radiosonde coded message for transmission, which of the following adiabatic charts (MF3-31s) are used?
1. B and C only
2. A and B only
3. A and C only
4. A, B, and C

5-14. Which of the following corrections is NOT applied to the temperature and humidity ordinate values?
1. Observer
2. Recorder
3. Drift
4. Paper

5-15. The thermistor on the prebaseline radiosonde is considered useable when 25°C indicates what ordinate?
1. 60.0
2. 65.0
3. 70.0
4. 75.0

5-16. Which of the following statements describes the entry of an annotation of missing data on a selected level drawn on the recorder record?
1. MISDA, on the level you selected at the end of the missing data
2. MISDA, on the level you select at the beginning of the missing data
3. MISDA, on the level you select in a strata of missing data
4. MISDA, on the level you select at the beginning and end of the missing data

5-17. The type of battery used with a VIZ ACCU-LOK transmitter is a/an
1. dry cell
2. water-activated
3. electric-activated
4. solar power

5-18. Which of the following statements is NOT a precaution that must be taken when you install the hygristor on the radiosonde?
1. Open the hygristor container just before the prerelease check
2. Use the hygristor only if the humidity is greater than 20 percent
3. Handle the hygristor by the edges
4. Reject the hygristor if your skin comes into contact with the element

5-19. A complete surface observation is required as near as possible to the time of the balloon release provided you do so within what maximum period of time prior to the release?
1. 10 min
2. 15 min
3. 20 min
4. 25 min

5-20. The radiosonde should be allowed an exposure time in the outside air of at least 10 minutes when the temperature difference between the shelter and the outside air exceed what maximum number of degrees?
1. 15°C
2. 20°C
3. 25°C
4. 30°C

5-21. When a superadiabatic lapse rate has been identified, which of the following notations is entered on the recorder record?
1. Supers
2. Supers
3. Rechecked
4. Rechecked

5-22. Which of the following items is NOT a prerequisite for a radiosonde transmitter release?
1. Transmitter check
2. Ground equipment check
3. Determining reason for termination
4. Balloon inflated

5-23. When you install a thermistor on a radiosonde, what precaution should be observed?
1. Never touch the white coating of the thermistor with your skin
2. Install the thermistor right side up
3. Replace the thermistor prior to release
4. Coat the thermistor with a water repellent spray

5-24. While tracking the radiosonde, the primary task of the observer at the recorder is which of the following?
1. To obtain an accurate and continuous recording of the signal
2. To evaluate the recorder record while the balloon is ascending
3. To complete the evaluation as soon as possible after the termination of the flight
4. To encode the evaluated data as soon as possible

In answering items 5-25 through 5-27, select from column B the location of the position of the evaluated data on each level which applies to the terms listed in column A.

	A. Terms	B. Position Locations
5-25.	Pressure contact value	1. To the right of the temperature trace and below the level below
5-26.	Temperature ordinate value	2. To the left of the temperature trace and above the level
5-27.	Humidity ordinate value	3. Within the first five ordinates and above the level
		4. To the right of the temperature trace and above the level

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5-28. All adiabatic charts (MF3-31s) should be prepared in a clear and legible manner for what reason?
1. So the actual data may be encoded
2. So the forecaster can use the forms to brief pilots
3. So the icing levels can be identified
4. So forms may be microfilmed for use as a climatological record

5-29. On a recorder record, the location of the station identification stamp is placed on the
1. left side of the recorder record
2. right side of the recorder record
3. tenth ordinate line attaching at the right edge of the stamp
4. tenth ordinate line directly below the preflight circuit check line, attaching at the left edge of the stamp

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Learning Objective: Identify the procedures for collecting, recording, and preparing for transmission of winds aloft observations.

5-30. The height above the surface (MF5-20) for a RAWIN observation is obtained from the
1. pressure altitude curve
2. time altitude curve
3. adiabatic chart
4. height given for the 100-gram balloon

5-31. The altitude entered in the RAWIN time altitude data block is (MF5-20) is obtained from the
1. recorder record
2. baroswitch calibration chart
3. SKEW-T, log P
4. adiabatic charts

5-32. Which of the following observations is NOT a method for determining winds aloft above your station?
1. PIBAL
2. RABAL
3. WNBAL
4. RAWIN

5-33. What statement is unique to a PIBAL observation?
1. The balloon is inflated to rise with a predetermined and constant ascension rate
2. The balloon is tracked visually by means of a theodalite
3. The balloon can be tracked during the night by use of a small light
4. The balloon can be released during strong winds

5-34. Winds aloft may be calculated during a RAWIN observation by using all EXCEPT which of the following angular value combinations?
1. Azimuth and elevation only
2. Azimuth, height, and slant range
3. Azimuth, height, and elevation angle
4. Azimuth, slant range, and elevation

5-35. When you use an AN/GMD-1 tracking unit, the accuracy of the winds aloft is seriously affected if the angular readings fall within which of the following zones?
1. Jet stream
2. Limiting angle
3. Tropopause
4. Thermal

5-36. A land type theodolite is more accurately described by which of the following statements?
1. It may also be used aboard ship
2. The line of sight is bent through an angle of 90 degrees
3. The theodolite is the same as a transit telescope
4. It can be moved when an obstruction is in the line of sight

5-37. On the winds aloft computation sheet (MF 5-20), the pressure used in the RAWIN time-altitude dated block is taken from the
1. adiabatic charts
2. baroswitch calibration chart
3. SKEW-T, log P
4. recorder record

In answering items 5-38 through 5-40,select from column B the wind equipment which applies to each method used to obtain winds aloft listed in column A.

	A. Methods	B. Wind Equipment
5-38.	PIBAL	1. AN/GMD-1
5-39.	RABAL	2. Computer
5-40.	RAWIN	3. Theodolite
		4. Plotting board

5-41. The AN/GMD-1 control recorder automatically and manually prints on a paper tape the simultaneous readings of all EXCEPT which of the following data?
1. Azimuth angles
2. Elevation angles
3. Elapsed time
4. Height of the balloon

5-42. You must smooth the elevation angles when the angles are less than what maximum number of degrees?
1. 21°
2. 18°
3. 15°
4. 12°

Learning Objective: Recognize, decode, and encode surface synoptic reports.

● For items 5-43 through 5-62, use the land station synoptic format as shown in unit 3, lesson 1 and the following synoptic report.

AAXX 15124 72454 11530 83425 11016 21058 39854 49860 56007 60061 78787 888// 921// 333 11011 21039 70066 88857 90106

5-43. What is the day of the month?
1. 01
2. 12
3. 15
4. 24

5-44. What is the wind direction?
1. 250
2. 340
3. 342
4. 425

5-45. What group is used to report the height of the low cloud to the nearest 30 meters?
1. 11011
2. 333
3. 888//
4. 921//

5-46. What is the code number for the total cloud cover?
1. 8
2. 7
3. 6
4. 5

5-47. What group indicator is used to report the amount of precipitation?
1. 8
2. 2
3. 6
4. 4

5-48. What code numbers are used to report the past weather?
1. 88
2. 87
3. 78
4. 61

5-49. What is the past maximum temperature?
1. -01.1°C
2. +01.1°C
3. +03.9°C
4. +11°C

5-50. What is the wind speed?
1. 16
2. 25
3. 30
4. 54

5-51. What is the temperature?
1. -1.6°C
2. -16°C
3. + 1.6°C
4. +16°C

5-52. What is the sea level pressure?
1. 854
2. 860
3. 985.4
4. 986.0

5-53. What code figure is used to report the middle cloud?
1. 7
2. 8
3. 9
4. /

5-54. What is the station pressure?
1. 105.8
2. 854.0
3. 985.4
4. 986.0

5-55. What code number is used to report the present weather?
1. 61
2. 78
3. 87
4. 88

5-56. What is the past minimum temperature?
1. -01.1°C
2. -03.9°C
3. +01.1°C
4. +03.9°C

5-57. What is the station number?
1. 724
2. 115
3. 530
4. 454

5-58. What is the 3-hour pressure change?
1. 00.7 mb
2. 05.6 mb
3. 06.0 mb
4. 07.0 mb

5-59. What group is used to report special phenomena?
1. 9
2. 8
3. 7
4. 6

5-60. What is the time of the observation?
1. 0600
2. 1200
3. 1800
4. 0000

5-61. What is the dew point temperature?
1. +58°C
2. +5.8°C
3. -58°C
4. -5.8°C

5-62. What group is used to report the 24-hour precipitation amount?
1. 5
2. 6
3. 7
4. 8

● For items 5-63 through 5-74, use the ship synoptic report format as shown in unit 3, lesson 1 and the following synoptic report.

NJKH 08004 99628 70325 11561 80446 11021
21030 40001 58015 72687 86808 920// 22216
00100 20503 32412 40805 51003 61021

5-63. What is the period of the wind wave?
1. 03
2. 05
3. 12
4. 24

5-64. What value is reported for the height of the first swell wave?
1. 03
2. 05
3. 08
4. 10

5-65. What value is reported for the height of the second swell wave?
1. 03
2. 05
3. 08
4. 10

5-66. What code number is used to report the visibility?
1. 46
2. 56
3. 61
4. 80

5-67. What group indicator is used to report the ice on ship with a sea temperature of 10°C?
1. ICE
2. 6
3. 5
4. 4

5-68. What is the longitude of the ship?
1. 32.5°E
2. 32.5°W
3. 32.5°N
4. 32.5°S

5-69. What is the sea surface water temperature?
1. -1.0
2. -10.0
3. + 1.0
4. +10.0

5-70. What is the direction of the number one swell wave?
1. 10
2. 12
3. 21
4. 24

5-71. What code number is used to report the quadrant of the globe?
1. 5
2. 6
3. 7
4. 8

5-72. What is the wind direction and speed?
1. 040° 46 knots
2. 044° 6 knots
3. 100° 21 knots
4. 010° 21 knots

5-73. What code numbers are used to report the ship's course and speed?
1. 16
2. 21
3. 22
4. 2216

5-74. What is the latitude of the ship?
1. 62.8°E
2. 62.8°S
3. 62.8°W
4. 62.8°N

5-75. What indicator group is used to identify the presence and state of sea ice and ice of land origin?
1. 1
2. 2
3. 3
4. ICE

Assignment 6

Plotting Surface Charts; Plotting SKEW T, LOG P Diagram; Plotting Constant Pressure Charts; Plotting Sea Surface Temperature; Plotting Satellite Tracks

Textbook Assignment: Pages 3-2-1 through 3-6-10

Learning Objective: Identify the proper procedure for plotting synoptic surface charts.

In answering items 6-1 through 6-3, refer to figure 3-2-1 of your textbook. Select from column B the station circle position in which each weather element listed in column A is plotted on a land synoptic map.

	A. Weather Elements	B. Station Circle Positions
6-1.	ww Present weather	1. East of station circle
6-2.	appp barometric tendency	2. South of station center line
6-3.	C_L low cloud	3. West of station circle
		4. North of station center line

6-4. Around the station circle of the station model for plotting airways reports, in what order are the symbols for low, middle, and high clouds arranged?
1. CL - north of center line; CM - north of center line above CL; CH - south of center line
2. CL - south of center line; CM - north of center line; CH - north of center line above CM
3. CL - north of center line; CM - north of center line above CL; CH - north of center line above CM
4. CL - south of center line; CM - south of center line below CL; CH - north of center line

6-5. What plotting symbol is used to denote a 10 knot wind?
1. One flag
2. One pennant
3. One-half barb
4. One whole barb

6-6. When you are plotting shipboard synoptic observations, which of the following elements should be checked first?
1. Ship's position
2. Ship's present weather
3. Ship's wind direction and speed
4. Date and time of the observation

6-7. Which of the following station plots is correct for a 2 knot wind speed?

1. 

2. 

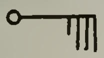
3. 

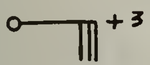
4. 

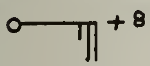
In items 6-8 through 6-10, refer to figure 3-2-2 in your textbook. Select from column B the station circle position in which each weather element listed in column A is plotted in a shipboard code plotting.

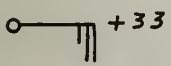
	A. Weather Elements	B. Station Circle Positions
6-8.	$T_dT_dT_d$ Dew point temperature	1. Southeast quadrant
6-9.	TTT Temperature	2. Southwest quadrant
6-10.	PPPP Sea level pressure	3. Northeast quadrant
		4. Northwest quadrant

6-11. The most important information on a plotted surface chart is which of the following entries?
1. Date and time
2. Plotter's name
3. Decoder's name
4. Forecaster's name

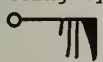
6-12. When the METAR code is used for a wind direction of 090° at 25 knots with gusts up to 33 knots, which of the following plotted wind reports is correct?
1. 

2. 

3. 

4. 

6-13. The source for obtaining weather charts used for plotting synoptic reports is which of the following publications?
1. Air Weather Service Products (105-52)
2. FMH-2 (NA-50-ID-2)
3. Defense Mapping Agency
4. National Weather Service

6-14. Assume that the surface wind at a weather station is from 090° at 75 knots. What plotting symbol is used?
1. 

2. 

3. 

4. 

6-15. The maps and charts plotted at any given weather station are determined by all EXCEPT which of the following factors?
1. Geographical location
2. Area of responsibility
3. Operational requirements
4. Present weather conditions

6-16. Which of the following coded temperature and dew point values is plotted correctly?
1. 3.8 and 5.1
2. -3.8 and -5.1
3. -03.8 and -05.1
4. -04 and -05

6-17. When you plot a surface synoptic chart, which of the following actions is the most important?
1. Accuracy
2. Neatness
3. Speed
4. Discarding erroneous reports

6-18. Which of the following past positions of a low pressure center on the 14th at 0000Z is plotted correctly?
1. 14/00Z
⊗
2. ⊗14/00Z
3. ⊗
14/00Z
4. 14/00Z ⊗

6-19. Which of the following synoptic observation times are normally used for plotting surface charts?
1. 0000 and 1200 GMT
2. 0000, 0800, and 1600 GMT
3. 0000, 0600, 1200, and 1800 GMT
4. 0000, 0400, 0800, 1200, 1600, and 2000 GMT

6-20. The source for encoding instructions for synoptic observations made at land stations is which of the following publications?
1. FMH No. 1, Surface Observations (NA-50-ID-1)
2. FMH No. 2, Synoptic Code (NA-50-ID-2)
3. Manual for Synoptic Code (NA-50-ID-506)
4. FMH No. 6, Upper Wind Codes (NA-50-ID-6)

6-21. A correct plot for a single missing number for a temperature value is described by which of the following statements?
1. Plot an X for the digit that is missing
2. Plot an M for the digit that is missing
3. Plot a / for the digit that is missing
4. Plot an M for the whole temperature value

Learning Objective: Identify the procedure for plotting a complete rawinsonde report on a SKEW T, LOG P diagram.

6-22. The information needed to plot the SKEW T, Log P diagram comes from what code?
1. Airways
2. Synoptic
3. Radiosonde
4. METAR

6-23. The procedure used to determine dew-point temperature is described in which of the following statements?
1. Add the dew-point depression to the wet-bulb temperature
2. Subtract the dew-point depression from the wet-bulb temperature
3. Add the dew-point depression to the temperature
4. Subtract the dew-point depression from the temperature

6-24. Isotherms on the SKEW T are lines of what equal value?
1. Temperature
2. Pressure
3. Wind speed
4. Dew point

6-25. When plotting temperature on the SKEW T, the temperature is plotted to what value?
1. Whole degree Celsius
2. Tenth of a degree Celsius
3. Whole degree Fahrenheit
4. Tenth of a degree Fahrenheit

6-26. The isotherm lines are spaced in increments of how many degrees?
1. 1°C
2. 5°C
3. 10°C
4. 1°F

6-27. To determine the exact height for a temperature value, what item on the SKEW T does the forecaster use?
1. Temperature curve
2. Dew-point curve
3. Pressure altitude curve
4. Mandatory height curve

6-28. Isobars on the SKEW T are lines of what equal value?
1. Temperature
2. Pressure
3. Wind speed
4. Dew point

6-29. When the PA curve is plotted on the SKEW T, each isotherm line is equal to how many meters?
1. 100
2. 150
3. 1000
4. 1500

6-30. The completed SKEW T, Log P diagram presents a vertical cross-section of the atmosphere. Which of the following values is NOT depicted on the SKEW T?
1. Temperature
2. Dew point
3. Winds aloft
4. Humidity

6-31. When the code numbers for the 1000 mb level are 00605, what is the height?
1. 50 m
2. 605 m
3. 105 m
4. -105 m

● For items 6-32 through 6-46, use the following rawinsonde report.

TTAA 62121 72409 99010 16459 04512 00107

16258 04510 85490 13234 07512 70098 03848

18030 50576 10516 26532 40745 20541 28050

30952 35964 27068 25142 481// 27077 20220

591// 27580 15398 621// 26588 10650 609//

27090 88182 639// 28097 77280 28110 41820 ⓓ

TTBB 6212/ 72409 00010 16459 11976 14238

22952 15825 33919 17250 44850 13234 55760

07630 66736 05856 77700 03848 88660 00459

99640 01323 11500 10516 22489 10517 33429

16547 44377 23358 55278 40165 66182 639//

77156 601// ⓓ

PPBB 62120 72409 90012 04512

05010 05013 90346 06012 07010

09014 90789 11018 14520 17025

91246 20031 23028 25534 9205/

27048 27053 93057 26566 27070

28078 94014 28110 28097 26588

9503/ 26590 27090 ⓓ

TTCC 62125 72409 70872 583// 27098 50085

551// 28070 30415 501// 28555 20683 449//

29048 10152 401// 31040 07397 373// 31543

05630 351// 32060 88999 77960 26599 44538

TTDD 6212/ 72409 11870 619// 22810 597//

33200 449// 44100 401// 55050 351//

PPDD 62120 72409 955// 26599

968// 28070 9708/ 28069 28555

990// 30045 1004/ 30542 31040

11029 31040 31543 32060

6-32. What is the temperature at the 850 mb level?
1. -3.4°C
2. -13.2°C
3. +3.4°C
4. +13.2°C

6-33. What is the pressure at the tropopause level?
1. 182 mb
2. 280 mb
3. 639 mb
4. 816 mb

6-34. Part TTAA indicates which of the following data?
1. Significant level only
2. Mandatory level only
3. Significant and mandatory levels
4. Upper wind only

6-35. What is the wind direction and speed at the 200 mb level?
1. 153° 98 kn
2. 270° 68 kn
3. 275° 80 kn
4. 265° 88 kn

6-36. Part TTBB indicates which of the following data?
1. Significant level only
2. Mandatory level only
3. Significant and mandatory levels
4. Upper wind

6-37. What is the wind direction and speed at the 102,000 foot level?
1. 11029
2. 31040
3. 31543
4. 32060

6-38. What is the dew-point depression at the 700 mb level?
1. 3.8
2. 4.8
3. 38
4. 48

6-39. In part TTAA, what is the maximum wind speed reported?
1. 80 kts
2. 100 kts
3. 110 kts
4. 281 kts

6-40. In part TTAA, what group is reporting the surface pressure?
1. 04512
2. 16459
3. 99010
4. 72409

6-41. What is the height of the 100 mb level?
1. 1065 m
2. 1650 m
3. 2650 m
4. 6500 m

6-42. Part PPBB indicates which of the following data?
1. Significant level only
2. Mandatory level only
3. Significant and mandatory levels
4. Upper wind only

6-43. What is the wind direction and speed at the 8,000-foot level?
1. 11018
2. 14520
3. 17025
4. 90789

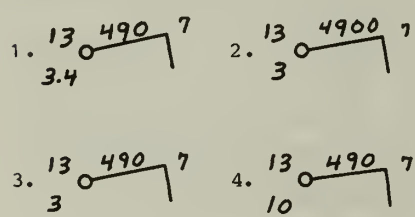
6-44. What is the dew-point depression for the 489 mb level?
1. 10.5°
2. 10°
3. 17°
4. 1.7°

6-45. Which of the following times indicates the time of the radiosonde report?
1. 0000Z
2. 0600Z
3. 1200Z
4. 1800Z

6-46. What is the height of the 1000 mb level?
1. 107 m
2. 107 ft
3. 1070 m
4. 1070 ft

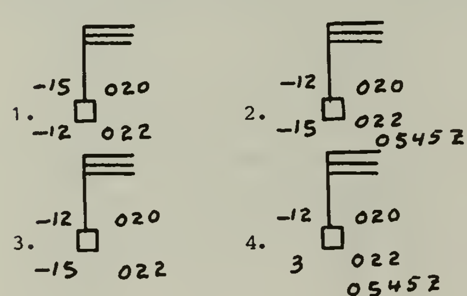
Learning Objective: Determine how data for the standard (mandatory) levels is entered on an upper level plotting chart.

6-47. Assume that the radiosonde report showed the 850 mb level as 85490 13234 07512. How should this be plotted?



6-48. Which of the following pressures is NOT a mandatory pressure level?
1. 400 mb
2. 500 mb
3. 600 mb
4. 700 mb

6-49. Which of the following RECCO plotting models is correct?



6-50. Which of the following parts of the radiosonde report contains the mandatory level data?
1. TTAA
2. TTBB
3. TTDD
4. PPBB

Learning Objective: Identify the procedures for plotting sea surface temperature and bathythermograph (BT) data.

● For item 6-51 use the following BT report.

JXX 20019 0000/ 73003 07558 88888

00261 07249 43238 72240 91246 99901

15250 57225 81199 99902 27150 96112

99903 39081 99904 24065 NJKH

6-51. What is the sea surface temperature?
1. 23.8°C
2. 24.0°C
3. 24.9°C
4. 26.1°C

6-52. The sea surface temperature is indicated by which of the following symbolic letters?
1. Ss Ss Ss
2. Sw Ew Aw
3. Sw Sw Sw
4. Tw Tw Tw

6-53. When sea surface temperatures are plotted, what symbol is used to differentiate them from the other plotted data?

1. •▽

2. •△

3. ▽

4. △

6-54. In the shipboard synoptic report, how is a sea surface temperature of 50.0°F encoded?
1. 050
2. 500
3. 010
4. 100

6-55. The sea surface temperature follows which of the following symbolic indicators?
1. 1
2. 2
3. 3
4. 0

6-56. What (a) latitude and (b) longitude is correct for a BT position encoded as 73018 13248?
1. (a) 30° 18'S (b) 132° 48'E
2. (a) 30° 18'N (b) 132° 48'W
3. (a) 30.18°N (b) 132.48°E
4. (a) 30.18°N (b) 132.48°W

● For item 6-57 use the following ship synoptic report.

SHIP 07004 99255 70895 41598 30812 10240

20200 40125 51006 70182 83200 22200 00245

20204 334// 40404

6-57. What is the sea surface temperature?
1. 24.5°C
2. 20.4°C
3. 20.0°C
4. 18.2°C

Learning Objective: Determine the information necessary to track meteorological satellites over your station.

6-58. When you see TBUS 1 in the heading of an APT predict message, what is indicated?
1. The satellite has a north-to-south nighttime picture taking orbit
2. The satellite has a south-to-north picture taking orbit
3. The satellite has a north-to-south daytime picture taking orbit
4. The satellite is geostationary

In answering items 6-59 through 6-62, select from column B the information which applies to the parts in column A of a APT predict message.

	A. Parts	B. Information
6-59.	I	1. Subpoint track for southern hemisphere
6-60.	II	2. Remarks pertinent to the operation of the satellite
6-61.	III	3. Information on the first, fourth, eighth and twelveth orbit of the day
6-62.	IV	4. Subpoint track for northern hemisphere

● For items 6-63 through 6-70, use the following APT predict message.

PART I

09236 01019 05101 00481 T0108 L2528

92400 23536 10595

92440 92011 25289

92481 60446 35174

NIGHT PART II

02800 070065 04800 141081 06800 212097

08810 283115 10810 353135 12810 423158

14810 493185 16810 562219 18820 630266

20820 696338 22820 757466 24820 803735

NIGHT PART III

02805 070033 04805 141017 06815 212000

08818 283017 10818 353036 12818 423059

14828 493086 16828 561120 18828 629167

20828 695238 22838 756365 24838 803632

26837 810083 28837 771408

DAY PART II

26821 810188 28821 770510 30821 711662

32821 646743 34821 579795 36822 510767

38822 441739 40822 371716 42822 301695

44822 231677 46812 160660 48812 089644

50812 019628

DAY PART III

52817 051612 54827 122596 56827 192580

58827 263562 60827 333543 62827 403522

64827 472496 66837 541465 68837 609423

70837 676361 72837 738256 74837 791045

PART IV

REMARKS NONE

6-63. What is the longitude octant of the fourth orbit?
1. 1
2. 2
3. 3
4. 4

6-64. What subpoint latitude/longitude groups are reported in the tenth minute for the northern hemisphere?
1. 333543
2. 353036
3. 353135
4. 371736

6-65. What is the ascending node time of the eighth orbit of the day?
1. 02: 35: 36Z
2. 09: 20: 11Z
3. 20: 11: 25Z
4. 23: 53: 01Z

6-66. What is the time of the satellite's nodal period?
1. 108 min
2. 101 min 8 sec
3. 1 min 8 sec
4. 1 hr 8 min

6-67. What group indicates the longitude of the ascending node?
1. 05101
2. 00481
3. T0108
4. L2528

6-68. What is the longitude increment?
1. 25° 28'
2. 25.28°
3. 125° 28'
4. 125.28°

6-69. What is the ascending node time of the first reference orbit?
1. 05: 10: 10Z
2. 10: 19: 51Z
3. 19: 51: 01Z
4. 19: 05: 01Z

6-70. What is the first reference orbit number?
1. 481
2. 1019
3. 5101
4. 9236

Assignment 7

Plotting Radiological Fallout Predictions; Upper Air Reports; Filing Teletype Reports; Chart Preparation and Representation

Textbook Assignment: Pages 3-7-1 through 4-2-5

Learning Objective: Identify information necessary to determine areas which are potentially hazardous because of fallout following a nuclear explosion.

7-1. What does the group YYYYY in a RADFO fallout warning message indicate?
1. Weapon size in kilotons
2. Weapon size in megatons
3. Month, day, year the detonation occurred
4. Size of the fallout zone in yards

7-2. When you detonate a nuclear weapon at a given position, the message that gives you the approximate location of its radiological fallout is known as what type of FADFO message?
1. Fallout warning
2. Preburst prediction
3. RADFO area
4. RADFO position

7-3. When a RADFO diagram is constructed, the area of high-yield is indicated by what color?
1. Red
2. White
3. Blue
4. Black

7-4. For a position of 30°S 100°E in a RADFO preburst message, which of the following position groups (QLLLL) is encoded correctly?
1. 23000
2. 23010
3. 73010
4. 73000

7-5. Which of the following statements describes GG in a RADFO fallout warning message?
1. The forecast time of the detonation
2. The time of the message
3. The time of the detonation
4. The time span of the message

- In items 7-6 through 7-12, use the RADFO message below. The message is a copy of part of an actual message.

PRE-BURST PREDICTION, 24 HR FCST FROM 00Z 14 SEP 84

FORMAT QLLLL Tddss DDDDD Tddss DDDDD

02070 13025 00012 22820 00080 02575 13030
00018 22828 00100 03080 33228 00015 52530
00120 03585 33225 00013 52524 00110 14000
53431 00019 62235 00130 14515 53433 00022
62240 00160

7-6. What is the speed of the effective fallout wind for the high-yield at position 14000?
1. 24 Kn
2. 30 Kn
3. 35 Kn
4. 40 Kn

7-7. What is the direction of the effective fallout wind for the low-yield at position 02575?
1. 280°
2. 300°
3. 320°
4. 340°

7-8. What is the greatest downwind distance that 200 roentgens would reach at position 03080 for the high-yield?
1. 110
2. 120
3. 130
4. 160

7-9. What is the high-yield template for position 14515?
1. CHARLIE
2. DELTA
3. ECHO
4. FOXTROT

7-10. What is the beginning time of the forecast period?
1. 00Z
2. 06Z
3. 12Z
4. 18Z

7-11. What is the low-yield template for position 03585?
1. ALFA
2. BRAVO
3. CHARLIE
4. DELTA

7-12. The forecast is valid for what time span?
1. 12 hr
2. 24 hr
3. 48 hr
4. 72 hr

Learning Objective: Identify the procedure for decoding and encoding upper air observation reports.

In answering items 7-13 through 7-15, select from column B the contents which apply to the sections listed in column A.

	A. Sections	B. Contents
7-13.	Section 1	1. Significant levels
7-14.	Section 2	2. Standard isobaric surfaces
7-15.	Section 3	3. Position
		4. Tropopause

7-16. The radiosonde code, part A and B, contains information for which of the following pressure levels?
1. 1000 to 100 mb
2. 1000 to 10 mb
3. Surface to 100 mb
4. Surface to 10 mb

7-17. What group indicates that the tropopause is NOT within the TTAA part?
1. 88999
2. 77999
3. 88///
4. 77///

● For items 7-18 through 7-23, use the following rawinsonde report.

TTAA 62121 72409 99010 16459 04512 00107
16258 04510 85490 13234 07512 70098 03848
18030 50576 10516 26532 40745 20541 28050
30952 35964 27068 25142 481// 27077 20220
591// 27580 15398 621// 26588 10650 609//
27090 88182 639// 28097 77280 28110 41820

TTBB 6212/ 72409 00010 16459 11976 14238
22952 15825 33919 17250 44850 13234 55760
07630 66736 05856 77700 03848 88660 00459
99640 01323 11500 10516 22489 10517 33429
16547 44377 23358 55278 40165 66182 639//
77156 601//

TTCC 62125 72409 70872 583// 27098 50085
551// 28070 30415 501// 28555 20683 449//
29048 10152 401// 31040 07397 373// 31543
05630 351// 32060 88999 77960 26599 44538

TTDD 6212/ 72409 11870 619// 22810 597//
33200 449// 44100 401// 55050 351//

7-18. What significant level number is assigned to the 919 pressure level?
1. 33
2. 55
3. 66
4. 77

7-19. What is the pressure at the significant level 55 in TTDD?
1. 50 mb
2. 50.5 mb
3. 5.5 mb
4. 5.0 mb

7-20. What is the temperature at the tropopause level?
1. -13.9°C
2. -18.2°C
3. -63.9°C
4. Missing

7-21. What group indicates the identification position of the report?
1. TTAA
2. 62121
3. 72409
4. 99010

7-22. What is the pressure at the level of maximum wind in TTCC?
1. 960 mb
2. 96.0 mb
3. 9.6 mb
4. 8.5 mb

7-23. What group indicates the surface wind speed and direction?
1. 99010
2. 16459
3. 11976
4. 04512

7-24. When a correction has been transmitted to a mandatory level that was previously sent, what transmission procedure must be followed?
1. Transmit only that part which was in error
2. Transmit the height and temperature only
3. Transmit the height, temperature, and wind
4. Transmit the entire sounding again

7-25. In a radiosonde code what indicator is used to report additional data?
1. 77
2. 88
3. 99
4. 101

7-26. What significant level indicates that the level is missing?
1. 77/// MISG
2. 77/// 39549
3. 77/// /////
4. 77XXX XXXXX

7-27. The first significant level entered on TTDD should use what indicator?
1. 00
2. 11
3. 22
4. 33

7-28. What indicator figures signifies that a shipboard position follows?
1. 99
2. 88
3. 77
4. 66

7-29. For a maximum wind to be encoded, the speed must be greater than what maximum speed?
1. 30 kt
2. 40 kt
3. 50 kt
4. 60 kt

Learning Objective: Identify the procedures for decoding and encoding winds aloft observation reports.

7-30. The encoded group 66055 27085 describes which, if any, of the following maximum wind occurrences?
1. Occurred at the terminating level of the sounding
2. Occurred within the sounding
3. Occurred at the last mandatory level
4. None of the above

7-31. Significant levels are determined for an upper air report for what reason?
1. To report strong winds
2. To report winds between mandatory levels
3. To make it possible to reconstruct the wind profile
4. To support the mandatory levels

In answering items 7-32 through 7-35, select from column B the description which applies to the letter identifiers in column A.

	A. Letters	B. Descriptions
7-32.	PP	1. Standard isobaric surface
7-33.	QQ	
7-34.	BB	2. Shipboard station
7-35.	DD	
		3. Land station
		4. Significant levels

7-36. In an upper wind report, what does the group $55nP_1P_1$ indicate?
1. The wind speed and direction are observed at an altitude approximately at the standard isobaric surface
2. The wind speed and direction are observed at an altitude determined by the means of a pressure device
3. The wind speed and direction are observed at an altitude determined by a computer
4. The wind speed and direction are observed at an altitude determined by an aircraft

7-37. An upper wind significant level defines a level at which what is observed about the wind(s)?
1. An abrupt change in speed and/or direction occurs
2. Strong winds occur only
3. Strong winds occur and match with a mandatory level
4. The wind gradually changes direction and the speed is greater than 60 knots

7-38. What is the maximum number of standard isobaric surfaces that can be reported for n in the upper wind report?
1. 5
2. 2
3. 3
4. 4

In answering items 7-39 through 7-42, select from column B the meaning which applies to the contraction listed in column A.

	A. Contractions	B. Meanings
7-39.	DLAD	1. Unfavorable sea conditions
7-40.	FINO	2. Unfavorable weather conditions
7-41.	PISE	3. Report missing, will not be filed
7-42.	PIWE	4. Report not ready for transmission

7-43. When a maximum wind group is encoded as 71500 28575, what is indicated by 1500?
1. 1,500 m
2. 1,500 ft
3. 45,000 m
4. 45,000 ft

● For items 7-44 through 7-48, use the following upper wind report.

PPAA 62120 72409 44385 07512 18030 26532
44340 28050 27068 27077 44320 27580 26588
27090 77280 28110 41828 Ⓓ

PPBB 62120 72409 90012 04512 05010 05013
90346 06012 07010 09014 90789 11018 14520
17025 91246 20031 23028 25534 9205/ 27048
27053 93057 26566 27070 28078 94014 28110
28097 26588 9503/ 26590 27090 Ⓓ

PPCC 62120 72409 44370 27098 28070 28555
44320 29048 31040 31543 44105 32060 77960
26599 44538 Ⓓ

PPDD 62120 72409 955// 26599 968// 28070
9708/ 28069 28555 990// 30045 1004/ 30542
31040 11029 31040 31543 32060 Ⓓ

7-44. What is the wind speed and direction for the 250 mb level?
1. 27077
2. 27068
3. 38050
4. 26588

7-45. In the group 44105 of part PPCC, what does the 05 indicate?
1. 105 mb
2. 50 mb
3. 05 mb
4. 0.5 mb

7-46. In the code group 44340 of part PPAA, the number 340 means there are three consecutive standard isoharic surfaces reported, starting with the
1. 40 mb level
2. 400 mb level
3. level after the 40 mb level
4. level after the 400 mb level

7-47. What is the wind speed and direction for the 8,000 foot level?
1. 11018
2. 14520
3. 17025
4. 18030

7-48. At the 112,000 foot level, what wind speed and direction were recorded, if any?
1. 31040
2. 31543
3. 32060
4. None

Learning Objective: Identify weather headings from teletype reports.

7-49. The purpose of the NAMOP teletype headings is to
1. aid identification and display
2. aid computers
3. set a standard used by WMO
4. aid the pilot in reading the data

In answering items 7-50 through 7-53, select from column B the meaning which applies to the message term listed in column A.

	A. Terms	B. Meanings
7-50.	FA	1. In-flight weather advisory
7-51.	FT	2. Area forecast
7-52.	SIGNET	3. Terminal aerodrome forecast
7-53.	AIRMET	4. Terminal forecast

7-54. Which of the following manuals is referred to as a Manual of Operations (MANOP)?
1. AFCSR 105-2
2. FMH-1
3. NA50-1G-518
4. CNOC 3140

In answering items 7-55 through 7-58, select from column B the meaning which applies to the MANOP heading symbol listed in column A.

	A. Symbols	B. Meanings
7-55.	TT	1. Geographical location
7-56.	AA	2. Time of message
7-57.	YY	3. Day of month
7-58.	GGgg	4. Type of data

Learning Objective: Determine the meaning of selected weather map symbols, and indicate the shading and color used for the features.

In answering items 7-59 through 7-62, select from column B the symbol which applies to the map feature listed in column A.

	A. Map Features	B. Symbols
7-59.	Rain showers	1. ≡
7-60.	Fog	2. $\dot{\nabla}$
7-61.	Thunderstorm	3. H
7-62.	High	4. ☈

In answering items 7-63 through 7-66, select from column B the color which applies to the map features listed in column A.

	A. Map Features	B. Colors
7-63.	Fog	1. Red
7-64.	Dust	2. Green
7-65.	Sand	3. Brown
7-66.	Snow	4. Yellow

In answering items 7-67 through 7-70, select from column B the color(s) which apply(s) to the front listed in column A.

	A. Fronts	B. Colors
7-67.	Stationary	1. Red and blue
7-68.	Occluded	2. Red
7-69.	Warm	3. Blue
7-70.	Cold	4. Purple

In answering items 7-71 through 7-74, select from column B the color which applies to the map feature listed in column A.

	A. Map Features	B. Colors
7-71.	Precipitation	1. Red
7-72.	Freezing precipitation	2. Green
7-73.	Tornadoes	3. Blue
7-74.	Thunderstorms	4. Purple

7-75. On a weather chart, the information found to identify the type of chart and its validation time is
1. weather chart schedule
2. upper right hand corner
3. upper left hand corner
4. identification block

Assignment 8

Surface Equipment; Upper Air Equipment

Textbook Assignment: Pages 5-1-1 through 5-2-7

Learning Objective: Identify the surface observation equipment used in taking surface observations.

8-1. The AN/GMQ-13( ) detector must be located at the same elevation as the projector and at what distance from the projector?
1. 400 to 900 ft
2. 200 to 500 ft
3. 600 to 1,000 ft
4. 800 to 1,200 ft

8-2. Which of the following parameters is NOT indicated on the AN/GMQ-29 analog recorder?
1. Sector visibility
2. Prevailing visibility
3. Flight visibility
4. Vertical visibility

8-3. The analog recorder on the AN/GMQ-29 is NOT used to record which of the following weather data?
1. Wind direction
2. Wind speed
3. Precipitation
4. Pressure

8-4. Which of the following systems is NOT part of the AN/GMQ-10?
1. Projector
2. Receiver
3. Recorder
4. Detector

8-5. Which of the following weather data is NOT obtained from the AN/GMQ-29?
1. Rainfall
2. Pressure
3. Humidity
4. Maximum temperature

8-6. To accurately determine the height of the bases of low clouds, which of the following types of equipment is used?
1. Ceiling light projector ML-121
2. Clinometer ML-119
3. Cloud height set AN/GMQ-13
4. All the above

8-7. In the northern hemisphere the instrument shelter face should always face towards what direction?
1. North
2. East
3. South
4. West

8-8. To determine the cloud base height from sightings with the ML-119 climometer, the average of three readings must be calculated. What other information must then be considered with the average height?
1. The height of the climometer above sea level must be added
2. The height of the climometer above sea level must be subtracted
3. The height of the ceiling light above sea level must be added
4. The height of the ceiling light above sea level must be subtracted

8-9. What is the visibility range of the AN/GMQ-10 during the day with a 500-foot baseline?
1. .01 to 2 mi
2. .05 to 2 mi
3. .05 to 3 mi
4. .1 to 2 mi

8-10. As a weather observer you are NOT responsible for which of the following PMS duties?
1. To up-date the work center PMS manual
2. To promptly notify the work center supervisor whenever the MRC is not fully understood
3. To perform assigned maintenance
4. To read the weekly schedule

8-11. Which of the following weather sensors is NOT part of the AN/GMQ-29?
1. Pressure
2. Visibility
3. Temperature
4. Dew point

8-12. After the elevation angle of the most clearly defined light spot on a cloud has been determined by sighting with a clinometer, how is the height of the cloud computed?
1. Divide the length of the baseline by the tangent of the angle
2. Multiply the length of the baseline by the tangent of the angle
3. Multiply the tangent of the angle by the distance from the observer to the spot
4. Take the square root of the difference between the square of the distance from the observer to the spot and the square of the baseline

8-13. When one thermometer on the ML-450A is damaged, which of the following procedures is used?
1. Replace the broken thermometer only
2. Replace both thermometers
3. Use the unbroken thermometer for dry-bulb readings
4. Use the unbroken thermometer for wet-bulb readings

8-14. The AN/GMQ-13( ) autographic records are retained for what minimum period of time before they are destroyed?
1. 1 mo
2. 2 mo
3. 3 mo
4. 6 mo

8-15. The townsend support is used to hold what thermometer(s)?
1. The maximum thermometer only
2. The minimum thermometer only
3. Both the minimum and maximum thermometers
4. The sling thermometers

8-16. What is the diameter of the collecting funnel of a .4-inch plastic rain gage?
1. 10 in.
2. 8 in.
3. 6 in.
4. 4 in.

8-17. A notable difference between the shipboard-type (ML-591/U) and the shore-type (ML-119) clinometer is that the
1. ML-591/U is usually permanently mounted and the ML-119 is portable
2. ML-119 is usually permanently mounted and the ML-591/U is portable
3. ML-119 uses a rotating beam ceiling light and the ML-591/U does not
4. ML-591/U uses a rotating beam ceiling light and the ML-119 does not

8-18. When moisture is observed on the dry bulb it should be wiped off before the temperature is recorded. The moisture should be removed how far in advance of the recording?
1. 2 to 4 min
2. 5 to 9 min
3. 10 to 15 min
4. 16 to 20 min

8-19. When the ship is approaching an extreme pressure condition that may carry the pen off the chart, you should make what adjustment, if any, to the marine barograph?
1. Remove the pen from the chart and wait for the condition to pass
2. Turn the pressure adjustment knob one mb higher each hour
3. Turn the pressure adjustment knob to move the pen about 40 mb away from the edge of the chart
4. None

8-20. The two-digit numbers displayed on the RVR converter should be multiplied by a factor of
1. 10
2. 100
3. 500
4. 1,000

8-21. The barometric pressure can be recorded on the marine barograph for how many continuous hours?
1. 96
2. 108
3. 130
4. 192

8-22. What time is the marine barograph chart changed?
1. At the 0000 LST observation
2. At the 1200 LST observation
3. At the closest synoptic observation to 0000 LST
4. At the closest synoptic observation to 1200 LST

8-23. The verticality of the ML-121 beam is checked with a theodolite and a
1. voltmeter
2. clinometer
3. spirit level
4. psychrometer

8-24. Which of the following components is NOT part of the AN/UMQ-5 system?
1. Transmitter
2. Rain gage
3. Indicator
4. Recorder

8-25. Which of the following AN/GMQ-13 components consists of a long persistence cathode-ray tube?
1. Detector
2. Projector
3. Recorder
4. Indicator

8-26. Which of the following examples indicates the days that the marine barograph chart should be changed?
1. 1, 5, 9, 13, etc.
2. 2, 6, 10, 14, etc.
3. 3, 7, 11, 15, etc.
4. 4, 8, 12, 16, etc.

8-27. Time adjustment on the Transmissometer AN/GMQ-10( ) should be applied whenever the error exceeds what minimum period of time?
1. 1 min
2. 2 1/2 min
3. 30 min
4. 5 min

8-28. Which of the following controls is NOT part of the control panel on the AN/GMQ-29?
1. Temperature resetting
2. System calibration selection
3. Time clock setting
4. Rainfall data resetting

8-29. The ceiling balloon is normally used to determine the height of the ceiling when the layer of clouds is equal to or less than
1. 2,500 ft
2. 3,500 ft
3. 4,500 ft
4. 5,000 ft

8-30. The station name, time check, and date-time group (LST) should be entered on the AN/GMQ-13 recorder chart when?
1. At the time of each 6-hourly observation
2. At the beginning and end of the chart or any detached portion
3. When notified of an aircraft accident in the vicinity of the station
4. When the recorder is stopped or started

8-31. The chart drive mechanism on the marine barograph, when fully wound, can run for what maximum period of time?
1. 16 days
2. 12 days
3. 8 days
4. 4 days

8-32. The projector of the AN/GMQ-13( ) has a duel light projecting system. If one lamp fails the second one will continue to sweep. What factor is observed when the second light beam is used?
1. The degree of penetration is greater
2. Breaks in clouds can be spotted easier
3. The rate of measurement is increased
4. The speed of sweep is decreased

8-33. The AN/UMQ-5 wind recorder uses which of the following inking systems?
1. Ballpoint pen
2. Drafting pen
3. Penpoint using a capillary action
4. Felt tip marker

8-34. The rotary movement of the projector of the AN/GMQ-13( ) rotates at a speed that permits the actual sweep of each optical system to last
1. 12 sec
2. 6 sec
3. 3 sec
4. 5 sec

8-35. The precision aneroid barometer, ML-448, indicates the atmospheric pressure in what limits of measurement?
1. Millibars of mercury only
2. Inches of mercury only
3. Millibars and inches of mercury
4. Millimeters of mercury

8-36. One reason for an equipment outage logbook is which of the following?
1. To determine the amount of down time in order to decrease the rental fees
2. To ensure that the entries in column 90 are correct
3. To determine what duty section has the most trouble
4. To serve as a trouble source for the maintenance personnel

8-37. Which of the following operations is NOT a function of the AN/GMQ-13( ) detector?
1. To feed the amplified signal received from the cloud base to the recorder indicator
2. To amplify the light reflected from the cloud base
3. To receive the light reflected from the cloud base
4. To project a modulated light beam

8-38. What factor has the greatest effect on a Marine barograph at sea?
1. Pitch
2. Roll
3. Vibration
4. Pressure

8-39. Which of the following components of the AN/GMQ-10( ) receiver generates a pulse signal?
1. Telescope
2. Telescope's objective lens
3. Photoelectric detector within the telescope
4. Iris diaphragm behind the telescope's objective lens

8-40. Which of the following is not a factor in the function of the PMS system?
1. Prevents rather than corrects maintenance
2. Reduces complex maintenance to simplified procedures
3. Detects areas that require additional training
4. Decreases the number of maintenance personnel

8-41. A time adjustment must be made on the AN/GMQ-29 wind recorder chart whenever the time error exceeds what maximum number of minutes?
1. 5
2. 10
3. 15
4. 20

8-42. If the visibility is 5,280 feet on the ID-1939/GMQ-10, what digital visibility is indicated?
1. 1
2. 52
3. 528
4. 5,280

8-43. Which of the following maintenance and material management systems is NOT applicable to all meteorological and oceanographic equipment?
1. Shipboard 3-M Systems, OPNAVINST 4790.4( )
2. Naval Aviation Maintenance Program (NAMP)
3. Meteorological Equipment Casualty Report (METREP)
4. Meteorological and Oceanographic Equipment Program (MOEP)

8-44. What is the maximum wind speed that can be recorded on the AN/UMQ-5 recorder?
1. 100 kn
2. 120 kn
3. 150 kn
4. 200 kn

8-45. Which of the following maintenance data is NOT listed on the MRCs?
1. The recommended skill level of the person who performs the work
2. The name of the work center supervisor
3. A brief definition of the PMS action to be done
4. The safety precautions to be observed

8-46. The AN/GMQ-10( ) is used at what point on the runway to determine the Runway Visual Range (RVR)?
1. Aid point
2. Approach end
3. Landing end
4. Intersection of two runways

8-47. Plastic calculators and evaluators can be stored at what maximum temperature?
1. 100°F
2. 120°F
3. 140°F
4. 160°F

8-48. The RVR system will convert the pulse rates from transmissometer sets to their corresponding visibility values. Without adjustment to the encoder disc, these pulse rates are based on what length baseline between the transmissometer projector and receiver?
1. 500 ft
2. 300 ft
3. 700 ft
4. 900 ft

8-49. Ceiling balloons should be stored in a dry, warm environment. What maximum temperature should never be exceeded during storage?
1. 120°F
2. 140°F
3. 180°F
4. 200°F

8-50. On the AN/GMQ-29 wind chart roll, which of the following time checks is NOT required?
1. Each 6-hour observation
2. Notification of an aircraft mishap
3. Disruption in the recorder trace
4. Beginning and end of storm force winds

8-51. The principle involved in measuring cloud height with an AN/GMQ-13( ) is based on
1. time
2. triangulation
3. intensity of projection
4. intensity of reflection

8-52. Which of the following chart identification is NOT entered at the beginning and end of each AN/GMQ-29 wind chart roll?
1. Observer's name
2. Station's name
3. Date/time
4. Chart feed rate (if different from normal)

8-53. When ceiling balloons have been exposed to temperatures below freezing, they should be stored at a temperature of 65°F or higher for what minimum number of hours prior to use?
1. 6 hrs
2. 9 hrs
3. 3 hrs
4. 12 hrs

8-54. When the AN/GMQ-13( ) is set on the standard baseline it can accurately determine a cloud height of approximately
1. 400 ft
2. 900 ft
3. 5,000 ft
4. 10,000 ft

8-55. To measure pressure, using the aneroid barometer (ML-448) what element is used?
1. Mercury tube
2. Vacuum tube
3. Pressure sensor
4. Sylphone cell

Learning Objective: Identify the upper air equipment used in taking an upper air observation.

8-56. What is the purpose of the balloon shroud?
1. To tie the balloon down during inflation
2. To facilitate handling and inflation of the balloon during a period of high winds
3. To decrease the decension rate after the balloon bursts
4. To condition the balloon prior to release

8-57. What is the frequency range of the AN/SMQ-1 receiver?
1. 390 to 410 MHz
2. 385 to 415 MHz
3. 395 to 425 MHz
4. 400 to 406 MHz

8-58. Which of the following RAOB data is NOT determined by the sounding?
1. Wind
2. Pressure
3. Temperature
4. Humidity

In answering items 8-59 through 8-62, select the function column B which applies to the color of the radiosonde transmitter test leads in column A.

	A. Colors	B. Functions
8-59.	White	1. Humidity
8-60.	Blue	2. Low reference
8-61.	Yellow	3. Midscale reference
8-62.	Red	4. Ground

8-63. The necessity to attach a small parachute on the radiosonde balloon train explains which of the following?
1. To slow the descent to improve radar tracking
2. To slow the descent to improve tracking by theodolite
3. To slow the descent to make a reverse tracking of the sounding
4. To slow the descent to minimize the danger to life and property

8-64. Which of the following data is NOT indicated by the AN/GMD-1 control recorder?
1. Azimuth and elevation angles
2. A printed record of azimuth and elevation angles
3. Elapsed time
4. Wind direction

8-65. Which of the following meteorological equipment is NOT a part of the RAWIN AN/GMD-1 system?
1. Tracking unit
2. Control recorder
3. Meteorological data storage
4. Meteorological data recorder

8-66. A part of the baroswitch on a radiosonde transmitter is which of the following functions?
1. Indicates pressure
2. Measures altitude
3. Measures angles
4. Indicates wind data

8-67. The AN/SMQ-1 antenna has what null region, if any?
1. Above only
2. Below only
3. Above and below
4. None

8-68. Through what sequence of units does the radiosonde signal travel when it passes through the RAWIN AN/GMD-1 system?
1. Tracking unit, control recorder, and meteorological data recorder
2. Control recorder, tracking unit, and meteorological data recorder
3. Control recorder, meteorological data recorder, and tracking unit
4. Tracking unit and meteorological data recorder only

8-69. To obtain a vertical profile of the atmosphere, what instrument should you use?
1. Transducer
2. Radiosonde transmitter
3. Transceiver
4. Humidity chamber

8-70. To record (in graphic form) weather information that is transmitted from a balloon-borne radiosonde, what meteorological equipment is used?
1. AN/GMD-1 tracking unit
2. AN/TMQ-5 recorder
3. AN/GMD-1 control recorder
4. AN/GMQ-29 recorder

8-71. Which of the following weather data is NOT transmitted by the radiosonde transmitter?
1. Dew point
2. Pressure
3. Temperature
4. Relative humidity

8-72. The radiosonde receptor AN/SMQ-1 may be used as a backup for which of the following meteorological equipment?
1. AN/GMD-1 tracking unit
2. AN/TMQ-5 recorder
3. AN/GMD-1 control recorder
4. AN/GMQ-29 recorder

8-73. Which of the following statements describes the AN/SMQ-1 antenna?
1. It is a single metal rod
2. It is a metal rod on the upper section and a metal tube or skirt on the lower section
3. It consists of one insulated quarter-wave length
4. It consists of one insulated half-wave length

8-74. Which of the following components is NOT part of the AN/SMQ-1 system?
1. Antenna
2. Receiver
3. Control recorder
4. Recorder

8-75. The shore station radiosonde transmitter is what frequency?

1. 403 MHz
2. 430 MHz
3. 1603 MHz
4. 1680 MHz

Assignment 9

Radar Equipment; Satellite Equipment; Drafting and Preparation of Naval Messages; Communications Equipment; Naval Environmental Display Station

Textbook Assignment: Pages 5-3-1 through 6-3-3

Learning Objective: Recognize the principles of operations and adjustments of radar equipment.

9-1. The purpose of the AN/GMH-6( ) is to
1. record weather information
2. check the output of a PPI scope
3. change the range marks in the AN/FPS-106 scope
4. provide a copy printout of weather pictures

9-2. What, if anything, should the AG do when the antenna on the AN/fps-106 elevates only to a maximum of 50°?
1. Adjust the maximum elevation control
2. Check the down elevation reading
3. Notify maintenance personnel
4. Nothing

9-3. What does the PPI scope display?
1. Altitude
2. Range only
3. Bearing only
4. Range and bearing

9-4. What component part of the AN/FPS-106(V) processes the return signal?
1. Antenna assembly
2. Control-Indicator
3. Receiver-Transmitter
4. Radome

9-5. Servicing and maintenance of radar equipment in the meteorology spaces is the responsibility of the
1. electronics personnel
2. AG3
3. AG2
4. AG1

9-6. Which of the following types of equipment permit the collection of information for weather purposes in overcast condition?
1. Range markers
2. Antennas
3. Radars
4. Cathode ray tubes

9-7. What are the elevation limits of the AN/FPS-106(V)?
1. -2° to +60°
2. -3° to +70°
3. -1° to +40°
4. -4° to +50°

9-8. Working with meteorological radar may be dangerous because of the presence of
1. X-rays
2. high voltage
3. a transmitter
4. modulators

Learning Objective: Recognize the basic procedures for receiving and recording of satellite imagery.

In answering items 9-9 through 9-11, select the satellite type from column B which applies to the system listed in column A.

	A. Systems	B. Satellite Types
9-9.	ITOS/NOAA	1. Equator orbiting
9-10.	SMS/GOES	2. Geostationary
9-11.	DMSP	3. Polar orbiting
		4. Sun synchronous

9-12. What satellite equipment is used aboard ship to copy DMSP data?
1. TMQ-29
2. TMQ-5
3. SMQ-3
4. SMQ-10

9-13. To keep the antenna pointed at the satellite requires a procedure called
1. orbiting
2. following
3. tracking
4. observing

9-14. From which, if any, of the following areas can a scanning radiometer (SR) sensor reflect and radiate energy?
1. Dark areas only
2. Daylight areas only
3. Dark and daylight areas
4. None of the above

9-15. The necessary data for tracking meteorological satellites is provided by which of the following messages?
1. Satellite synoptic
2. DMSP
3. GOES
4. APT predict

9-16. The AN/SMQ6 ground station equipment consists basically of an antenna system, a receiver, a tape recorder, and a
1. power control
2. facsimile recorder
3. power source
4. circuit breaker

In answering items 9-17 through 9-19, select the color from column B which applies to the satellite features listed in column A.

	A. Satellite Features	B. Colors
9-17.	Warm temperature	1. White
9-18.	Coldest temperature	2. Light gray
9-19.	Moderate temperature	3. Dark gray
		4. Light Brown

9-20. The purpose of a satellite facsimile recorder is to reproduce the meteorological information received from
1. land-line circuits
2. data processes
3. a recorder
4. satellite weather stations

Learning Objective: Determine the procedure for preparing, typing, and drafting naval messages.

9-21. Responsibility for assigning precedence to a naval message lies with the
1. communications watch officer
2. originator
3. duty officer
4. commanding officer or officer-in-charge, as appropriate

9-22. Guidelines for preparing naval messages are provided by which of the following publications?
1. FMH-1
2. FMH-2
3. NTP-3
4. NTP-4

9-23. COMDESRON sixtysix is entered correctly for a naval message by which of the following short titles?
1. COMDESRON 66
2. COMDESRON SIXTYSIX
3. COMDESRON SIXTY SIX
4. COMDESTON SIX SIX

9-24. When a special handling designator (SHD) is used on a SPECAT message, you should use which of the following procedures?
1. SHD is entered in the SPECAT block once only
2. SHD is entered in the SPECAT block twice only
3. SHD is entered in the SPECAT block three times only
4. SHD is entered in the SPECAT block five times

9-25. Which of the following types of naval messages is NOT part of the classified and unclassified narrative messages?
1. Single address
2. Multiple address
3. Book
4. Volume

9-26. The correct entry of a reference used in a naval message is indicated in which of the following examples?
1. 1. REF. FMH 3 CH 5
2. REF A FMH 3 CH 5
3. A. FMH 3 CH 5
4. REF FMH 3 CH 5

9-27. In the text of a naval message, DD-173, what is the maximum number of characters or spaces per line?
1. 40
2. 69
3. 75
4. 80

In answering items 9-28 through 9-31, select the category from column B which applies to the precedence prosign listed in column A.

	A. Precedence Prosigns	B. Categories
9-28.	Z	1. Priority
9-29.	Y	2. Immediate
9-30.	O	3. Flash
9-31.	P	4. Emergency command

9-32. Which of the following naval message standard subject identification codes is correct for number 3140?
1. 3140
2. N03140
3. // N03140 //
4. //N03140//

9-33. A message that was transmitted at 1230 GMT on the 14th day of September 1984 would have what date-time-group?
1. 141230Z SEP 84
2. 1230Z 14 SEP 84
3. 14 SEP 84 1230Z
4. SEP 84 141230Z

9-34. The position for the subject line of a naval message is identified in which of the following statements?
1. The first line following the classification line
2. The first line following the reference line
3. The first line following the INFO line
4. The first line following the TO line

In answering items 9-35 through 9-38, select the authorized symbol from column B which applies to the term listed in column A.

	A. Terms	B. Symbols
9-35.	Blob	1. 
9-36.	Hook	2. 
9-37.	Open parenthesis	3. 
9-38.	Fork	4. 

9-39. Which of the following message addresses is shown by an addressing collective?
1. FLENUMOCEANCEN MONTEREY CA
2. AIG SEVEN SIX ZERO EIGHT
3. AFGWC OFUTT AFB NE
4. NAVOCEANCOMDET ADAK AK

9-40. When ZPW 141013Z SEP 84 is entered in the message handling instructions block of the naval message form, what is indicated?
1. The exact time at which the information becomes obsolete
2. The exact time at which the message is transmitted
3. The time at which the message must be transmitted
4. The time at which the message was received

9-41. The format and ordinary language spelling of command short titles and geographical locations in naval message addressing is identified by what phrase?
1. Abbreviated message
2. Abbreviated short message
3. Plain language
4. Naval abbreviated message

9-42. Which of the following reference classifications should NOT be entered on a SECRET naval message?
1. (U)
2. (C)
3. (S)
4. (TS)

9-43. Which of the following precedences is NOT part of the message categories?
1. Routine
2. Rush
3. Priority
4. Flash

9-44. To downgrade and declassify classified naval messages, which of the following instructions provides general information?
1. NTP 3( )
2. DECASS PUB 3740.8( )
3. OPNAVINST 5510.1( )
4. OPNAVINST 3140.4( )

9-45. To obtain the naval message form DD-173, what source is used?
1. Naval Supply System
2. Local OCR company
3. Local print shop
4. On station print shop

9-46. A message encrypted for transmission only indicates which of the following message classification?
1. UNCLAS FOUO E F T O
2. UNCLAS E F T O FOUO
3. E F T O UNCLAS
4. FOUO E F T O UNCLAS

9-47. To align the DD-173 message form for correct typing, which of the following features is used?
1. The bottom line of the message heading
2. The bottom portion of the FROM line
3. The two extended horizontal lines on the upper left- and right-hand margins
4. The top line of the message heading

9-48. Which of the following classification designators is NOT correct for an entry on a naval message classification line?
1. U N C L A S
2. C O N F I D E N T I A L
3. S E C R E T
4. T O P S E C R E T

In answering items 9-49 through 9-52, select the general handling time from column B which applies to the message precedence listed in column A.

	A. Precedences	B. Handling times
9-49.	Routine	1. Less than 10 min
9-50.	Priority	2. 30 min
9-51.	Immediate	3. 3 hr
9-52.	Flash	4. 6 hr

9-53. A naval message with an (S) preceding the reference indicates which of the following conditions?
1. Standard reference
2. Classification of Secret
3. Single copy
4. Shore station copy

Learning Objective: Recognize the basic equipment used in the weather communication system.

In answering items 9-54 through 9-57, select the description of the data from column B which applies to the facsimile network listed in column A.

	A. Facsimile Networks	B. Descriptions of Data
9-54.	WFX 1234	1. Satellite material
9-55.	FOFAX	2. International high-altitude civilian aviation
9-56.	AFX 109	
9-57.	NAMFAX	3. Low-altitude aviation interests
		4. High-performance aircraft

9-58. When the COMEDS keyboard is used, what is meant by ETX?
1. End of text
2. Exit to next paragraph
3. Exit to next sentence
4. Exit to next page

9-59. Direct responsibility for managing landline teletypewriter network Services A, C, and O is what governmental authority?
1. National Weather Service
2. Civil Aeronautics Board (CAB)
3. Federal Communications Commission (FCC)
4. Federal Aviation Administration (FAA)

9-60. What two means are used for the transmission of weather teletype data?
1. Landline and radio
2. Radioteletype and radiotelegraphy
3. Facsimile and radio
4. Teletype and radio

9-61. Which of the following systems is NOT part of the CONUS facsimile network?
1. FOFAX
2. ALFAX
3. AFX109
4. NAMFAX

9-62. To transmit and receive weather data on the COMEDS circuits, what model teletypewriter is used?
1. Model 28 R/O
2. Model 40 Teletypewriter
3. Model 28 TT-48( )/UG
4. Model 28 TT-69( )/UG

9-63. The acronym for COMEDS represents what title?
1. CONUS Meteorological Display Service
2. CONUS Meteorological Defense System
3. CONUS Meteorological Data System
4. CONUS Meteorological Environmental Defense Service

9-64. A weather message sent over the ADWS system has a maximum of how many characters or spaces per line?
1. 40
2. 60
3. 69
4. 80

9-65. The AN/GMQ-27 weathervision transmits weather data by the use of
1. telephone
2. teletype
3. television
4. radar

9-66. Weather units ashore normally use what two types of teletypewriters?
1. Model 28 R/O and Model 40
2. Model 28 R/O and Model 28 TT-48 ( )/UG
3. Model 40 and Model 28 TT-48( )/UG
4. Model 28 TT-48( )/UG and Model 28 TT-69( )/UG

9-67. The weather facsimile network operates at how many scans per minute?
1. 60 or 120
2. 120 or 240
3. 150 or 250
4. 180 or 280

9-68. The Alden facsimile develops transmitted data by what principle?
1. Electrosensitivity
2. Electrostatically
3. By the Diazzo method
4. Electromechanically

9-69. The recording process of an Alden FAX is done by the use of a fax recorder and an
1. Alfax dry chemical paper
2. Alfax wet paper
3. Alfax electrosensitive paper
4. Alfax Ozalid paper

9-70. What feature of the COMEDS reduces the number of errors to near zero?
1. The preparation of messages on the keyboard display
2. The printer unit
3. Tape preparation
4. American Standard Code for Information Exchange

9-71. Where is the control center of the COMEDS circuit located?
1. NWS Kansas City, MO
2. FNOC Monterey, CA
3. CNOC Bay St. Louis, MS
4. ADWS Carswell AFB, TX

9-72. What is the operating frequency range of the R-1051/URR radio receiver?
1. 1 to 10 MHz
2. 2 to 20 MHz
3. 3 to 30 MHz
4. 2 to 30 MHz

Learning Objective: Identify the component parts of the naval environmental display station.

9-73. The NEDS network system is controlled by which of the following commands?
1. Fleet Numerical Oceanography Center
2. National Weather Service
3. Air Weather Service
4. Fleet Operations Weather Center

9-74. The control indicator group of the NEDS system does NOT include which of the following features?
1. GRAPHIC CRT screen
2. Alphanumeric CRT screen
3. Graphic pen interface
4. Weather vision system

9-75. Which of the following operations is NOT a function of a NEDS system?
1. Display weather charts
2. Hard copy printer
3. Observer environmental conditions
4. Store environmental data

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51	☐	☐	☐	☐	_____
52	☐	☐	☐	☐	_____
53	☐	☐	☐	☐	_____
54	☐	☐	☐	☐	_____
55	☐	☐	☐	☐	_____
56	☐	☐	☐	☐	_____
57	☐	☐	☐	☐	_____
58	☐	☐	☐	☐	_____
59	☐	☐	☐	☐	_____
60	☐	☐	☐	☐	_____
61	☐	☐	☐	☐	_____
62	☐	☐	☐	☐	_____
63	☐	☐	☐	☐	_____
64	☐	☐	☐	☐	_____
65	☐	☐	☐	☐	_____
66	☐	☐	☐	☐	_____
67	☐	☐	☐	☐	_____
68	☐	☐	☐	☐	_____
69	☐	☐	☐	☐	_____
70	☐	☐	☐	☐	_____
71	☐	☐	☐	☐	_____
72	☐	☐	☐	☐	_____
73	☐	☐	☐	☐	_____
74	☐	☐	☐	☐	_____
75	☐	☐	☐	☐	_____

PRINT OR TYPE

RTM/NRCC AEROGRAPHER'S MATE THIRD CLASS
NAVEDTRA 10369

NAME ______________________________ ADDRESS ______________________________
Last First Middle Street/Ship/Unit/Division, etc.

City or FPO State Zip

RANK/RATE ________ SOC. SEC. NO. ______________________ DESIGNATOR ________ ASSIGNMENT NO. ________

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE OTHER (Specify) ______________ DATE MAILED ________

SCORE

	1 T	2 F	3	4			1 T	2 F	3	4			1 T	2 F	3	4	
1	☐	☐	☐	☐	_____	26	☐	☐	☐	☐	_____	51	☐	☐	☐	☐	_____
2	☐	☐	☐	☐	_____	27	☐	☐	☐	☐	_____	52	☐	☐	☐	☐	_____
3	☐	☐	☐	☐	_____	28	☐	☐	☐	☐	_____	53	☐	☐	☐	☐	_____
4	☐	☐	☐	☐	_____	29	☐	☐	☐	☐	_____	54	☐	☐	☐	☐	_____
5	☐	☐	☐	☐	_____	30	☐	☐	☐	☐	_____	55	☐	☐	☐	☐	_____
6	☐	☐	☐	☐	_____	31	☐	☐	☐	☐	_____	56	☐	☐	☐	☐	_____
7	☐	☐	☐	☐	_____	32	☐	☐	☐	☐	_____	57	☐	☐	☐	☐	_____
8	☐	☐	☐	☐	_____	33	☐	☐	☐	☐	_____	58	☐	☐	☐	☐	_____
9	☐	☐	☐	☐	_____	34	☐	☐	☐	☐	_____	59	☐	☐	☐	☐	_____
10	☐	☐	☐	☐	_____	35	☐	☐	☐	☐	_____	60	☐	☐	☐	☐	_____
11	☐	☐	☐	☐	_____	36	☐	☐	☐	☐	_____	61	☐	☐	☐	☐	_____
12	☐	☐	☐	☐	_____	37	☐	☐	☐	☐	_____	62	☐	☐	☐	☐	_____
13	☐	☐	☐	☐	_____	38	☐	☐	☐	☐	_____	63	☐	☐	☐	☐	_____
14	☐	☐	☐	☐	_____	39	☐	☐	☐	☐	_____	64	☐	☐	☐	☐	_____
15	☐	☐	☐	☐	_____	40	☐	☐	☐	☐	_____	65	☐	☐	☐	☐	_____
16	☐	☐	☐	☐	_____	41	☐	☐	☐	☐	_____	66	☐	☐	☐	☐	_____
17	☐	☐	☐	☐	_____	42	☐	☐	☐	☐	_____	67	☐	☐	☐	☐	_____
18	☐	☐	☐	☐	_____	43	☐	☐	☐	☐	_____	68	☐	☐	☐	☐	_____
19	☐	☐	☐	☐	_____	44	☐	☐	☐	☐	_____	69	☐	☐	☐	☐	_____
20	☐	☐	☐	☐	_____	45	☐	☐	☐	☐	_____	70	☐	☐	☐	☐	_____
21	☐	☐	☐	☐	_____	46	☐	☐	☐	☐	_____	71	☐	☐	☐	☐	_____
22	☐	☐	☐	☐	_____	47	☐	☐	☐	☐	_____	72	☐	☐	☐	☐	_____
23	☐	☐	☐	☐	_____	48	☐	☐	☐	☐	_____	73	☐	☐	☐	☐	_____
24	☐	☐	☐	☐	_____	49	☐	☐	☐	☐	_____	74	☐	☐	☐	☐	_____
25	☐	☐	☐	☐	_____	50	☐	☐	☐	☐	_____	75	☐	☐	☐	☐	_____

PRINT OR TYPE

RTM/NRCC AEROGRAPHER'S MATE THIRD CLASS
NAVEDTRA 10369

NAME ______________________________ ADDRESS ______________________________
Last First Middle — Street/Ship/Unit/Division, etc.

____
City or FPO State Zip

RANK/RATE ______ SOC. SEC. NO. ______________ DESIGNATOR ______ ASSIGNMENT NO. ______

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE OTHER (Specify) ______________ DATE MAILED ______

SCORE

	1 T	2 F	3	4			1 T	2 F	3	4			1 T	2 F	3	4	
1	☐	☐	☐	☐	_____	26	☐	☐	☐	☐	_____	51	☐	☐	☐	☐	_____
2	☐	☐	☐	☐	_____	27	☐	☐	☐	☐	_____	52	☐	☐	☐	☐	_____
3	☐	☐	☐	☐	_____	28	☐	☐	☐	☐	_____	53	☐	☐	☐	☐	_____
4	☐	☐	☐	☐	_____	29	☐	☐	☐	☐	_____	54	☐	☐	☐	☐	_____
5	☐	☐	☐	☐	_____	30	☐	☐	☐	☐	_____	55	☐	☐	☐	☐	_____
6	☐	☐	☐	☐	_____	31	☐	☐	☐	☐	_____	56	☐	☐	☐	☐	_____
7	☐	☐	☐	☐	_____	32	☐	☐	☐	☐	_____	57	☐	☐	☐	☐	_____
8	☐	☐	☐	☐	_____	33	☐	☐	☐	☐	_____	58	☐	☐	☐	☐	_____
9	☐	☐	☐	☐	_____	34	☐	☐	☐	☐	_____	59	☐	☐	☐	☐	_____
10	☐	☐	☐	☐	_____	35	☐	☐	☐	☐	_____	60	☐	☐	☐	☐	_____
11	☐	☐	☐	☐	_____	36	☐	☐	☐	☐	_____	61	☐	☐	☐	☐	_____
12	☐	☐	☐	☐	_____	37	☐	☐	☐	☐	_____	62	☐	☐	☐	☐	_____
13	☐	☐	☐	☐	_____	38	☐	☐	☐	☐	_____	63	☐	☐	☐	☐	_____
14	☐	☐	☐	☐	_____	39	☐	☐	☐	☐	_____	64	☐	☐	☐	☐	_____
15	☐	☐	☐	☐	_____	40	☐	☐	☐	☐	_____	65	☐	☐	☐	☐	_____
16	☐	☐	☐	☐	_____	41	☐	☐	☐	☐	_____	66	☐	☐	☐	☐	_____
17	☐	☐	☐	☐	_____	42	☐	☐	☐	☐	_____	67	☐	☐	☐	☐	_____
18	☐	☐	☐	☐	_____	43	☐	☐	☐	☐	_____	68	☐	☐	☐	☐	_____
19	☐	☐	☐	☐	_____	44	☐	☐	☐	☐	_____	69	☐	☐	☐	☐	_____
20	☐	☐	☐	☐	_____	45	☐	☐	☐	☐	_____	70	☐	☐	☐	☐	_____
21	☐	☐	☐	☐	_____	46	☐	☐	☐	☐	_____	71	☐	☐	☐	☐	_____
22	☐	☐	☐	☐	_____	47	☐	☐	☐	☐	_____	72	☐	☐	☐	☐	_____
23	☐	☐	☐	☐	_____	48	☐	☐	☐	☐	_____	73	☐	☐	☐	☐	_____
24	☐	☐	☐	☐	_____	49	☐	☐	☐	☐	_____	74	☐	☐	☐	☐	_____
25	☐	☐	☐	☐	_____	50	☐	☐	☐	☐	_____	75	☐	☐	☐	☐	_____

PRINT OR TYPE

RTM/NRCC AEROGRAPHER'S MATE THIRD CLASS
NAVEDTRA 10369

NAME ____________________ ADDRESS ____________________
Last First Middle Street/Ship/Unit/Division, etc.

____
City or FPO State Zip

RANK/RATE ________ SOC. SEC. NO. ____________ DESIGNATOR ________ ASSIGNMENT NO. ________

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE OTHER (Specify) ____________ DATE MAILED ________

SCORE

	1 T	2 F	3	4			1 T	2 F	3	4			1 T	2 F	3	4	
1	☐	☐	☐	☐	_____	26	☐	☐	☐	☐	_____	51	☐	☐	☐	☐	_____
2	☐	☐	☐	☐	_____	27	☐	☐	☐	☐	_____	52	☐	☐	☐	☐	_____
3	☐	☐	☐	☐	_____	28	☐	☐	☐	☐	_____	53	☐	☐	☐	☐	_____
4	☐	☐	☐	☐	_____	29	☐	☐	☐	☐	_____	54	☐	☐	☐	☐	_____
5	☐	☐	☐	☐	_____	30	☐	☐	☐	☐	_____	55	☐	☐	☐	☐	_____
6	☐	☐	☐	☐	_____	31	☐	☐	☐	☐	_____	56	☐	☐	☐	☐	_____
7	☐	☐	☐	☐	_____	32	☐	☐	☐	☐	_____	57	☐	☐	☐	☐	_____
8	☐	☐	☐	☐	_____	33	☐	☐	☐	☐	_____	58	☐	☐	☐	☐	_____
9	☐	☐	☐	☐	_____	34	☐	☐	☐	☐	_____	59	☐	☐	☐	☐	_____
10	☐	☐	☐	☐	_____	35	☐	☐	☐	☐	_____	60	☐	☐	☐	☐	_____
11	☐	☐	☐	☐	_____	36	☐	☐	☐	☐	_____	61	☐	☐	☐	☐	_____
12	☐	☐	☐	☐	_____	37	☐	☐	☐	☐	_____	62	☐	☐	☐	☐	_____
13	☐	☐	☐	☐	_____	38	☐	☐	☐	☐	_____	63	☐	☐	☐	☐	_____
14	☐	☐	☐	☐	_____	39	☐	☐	☐	☐	_____	64	☐	☐	☐	☐	_____
15	☐	☐	☐	☐	_____	40	☐	☐	☐	☐	_____	65	☐	☐	☐	☐	_____
16	☐	☐	☐	☐	_____	41	☐	☐	☐	☐	_____	66	☐	☐	☐	☐	_____
17	☐	☐	☐	☐	_____	42	☐	☐	☐	☐	_____	67	☐	☐	☐	☐	_____
18	☐	☐	☐	☐	_____	43	☐	☐	☐	☐	_____	68	☐	☐	☐	☐	_____
19	☐	☐	☐	☐	_____	44	☐	☐	☐	☐	_____	69	☐	☐	☐	☐	_____
20	☐	☐	☐	☐	_____	45	☐	☐	☐	☐	_____	70	☐	☐	☐	☐	_____
21	☐	☐	☐	☐	_____	46	☐	☐	☐	☐	_____	71	☐	☐	☐	☐	_____
22	☐	☐	☐	☐	_____	47	☐	☐	☐	☐	_____	72	☐	☐	☐	☐	_____
23	☐	☐	☐	☐	_____	48	☐	☐	☐	☐	_____	73	☐	☐	☐	☐	_____
24	☐	☐	☐	☐	_____	49	☐	☐	☐	☐	_____	74	☐	☐	☐	☐	_____
25	☐	☐	☐	☐	_____	50	☐	☐	☐	☐	_____	75	☐	☐	☐	☐	_____

PRINT OR TYPE

RTM/NRCC AEROGRAPHER'S MATE THIRD CLASS
NAVEDTRA 10369

NAME ______________________________ ADDRESS ______________________________
Last First Middle Street/Ship/Unit/Division, etc.

____
City or FPO State Zip

RANK/RATE ________ SOC. SEC. NO. ________________ DESIGNATOR ________ ASSIGNMENT NO. ________

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE OTHER (Specify) ________________ DATE MAILED ________

SCORE

	1 T	2 F	3	4			1 T	2 F	3	4			1 T	2 F	3	4	
1	☐	☐	☐	☐	_____	26	☐	☐	☐	☐	_____	51	☐	☐	☐	☐	_____
2	☐	☐	☐	☐	_____	27	☐	☐	☐	☐	_____	52	☐	☐	☐	☐	_____
3	☐	☐	☐	☐	_____	28	☐	☐	☐	☐	_____	53	☐	☐	☐	☐	_____
4	☐	☐	☐	☐	_____	29	☐	☐	☐	☐	_____	54	☐	☐	☐	☐	_____
5	☐	☐	☐	☐	_____	30	☐	☐	☐	☐	_____	55	☐	☐	☐	☐	_____
6	☐	☐	☐	☐	_____	31	☐	☐	☐	☐	_____	56	☐	☐	☐	☐	_____
7	☐	☐	☐	☐	_____	32	☐	☐	☐	☐	_____	57	☐	☐	☐	☐	_____
8	☐	☐	☐	☐	_____	33	☐	☐	☐	☐	_____	58	☐	☐	☐	☐	_____
9	☐	☐	☐	☐	_____	34	☐	☐	☐	☐	_____	59	☐	☐	☐	☐	_____
10	☐	☐	☐	☐	_____	35	☐	☐	☐	☐	_____	60	☐	☐	☐	☐	_____
11	☐	☐	☐	☐	_____	36	☐	☐	☐	☐	_____	61	☐	☐	☐	☐	_____
12	☐	☐	☐	☐	_____	37	☐	☐	☐	☐	_____	62	☐	☐	☐	☐	_____
13	☐	☐	☐	☐	_____	38	☐	☐	☐	☐	_____	63	☐	☐	☐	☐	_____
14	☐	☐	☐	☐	_____	39	☐	☐	☐	☐	_____	64	☐	☐	☐	☐	_____
15	☐	☐	☐	☐	_____	40	☐	☐	☐	☐	_____	65	☐	☐	☐	☐	_____
16	☐	☐	☐	☐	_____	41	☐	☐	☐	☐	_____	66	☐	☐	☐	☐	_____
17	☐	☐	☐	☐	_____	42	☐	☐	☐	☐	_____	67	☐	☐	☐	☐	_____
18	☐	☐	☐	☐	_____	43	☐	☐	☐	☐	_____	68	☐	☐	☐	☐	_____
19	☐	☐	☐	☐	_____	44	☐	☐	☐	☐	_____	69	☐	☐	☐	☐	_____
20	☐	☐	☐	☐	_____	45	☐	☐	☐	☐	_____	70	☐	☐	☐	☐	_____
21	☐	☐	☐	☐	_____	46	☐	☐	☐	☐	_____	71	☐	☐	☐	☐	_____
22	☐	☐	☐	☐	_____	47	☐	☐	☐	☐	_____	72	☐	☐	☐	☐	_____
23	☐	☐	☐	☐	_____	48	☐	☐	☐	☐	_____	73	☐	☐	☐	☐	_____
24	☐	☐	☐	☐	_____	49	☐	☐	☐	☐	_____	74	☐	☐	☐	☐	_____
25	☐	☐	☐	☐	_____	50	☐	☐	☐	☐	_____	75	☐	☐	☐	☐	_____

PRINT OR TYPE

RTM/NRCC AEROGRAPHER'S MATE THIRD CLASS
NAVEDTRA 10369

NAME ______________________________ (Last, First, Middle)

ADDRESS ______________________________ (Street/Ship/Unit/Division, etc.)

______________________________ (City or FPO, State, Zip)

RANK/RATE ________ SOC. SEC. NO. ____________________ DESIGNATOR ________ ASSIGNMENT NO. ________

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE OTHER (Specify) ____________________ DATE MAILED ________

SCORE

	1 T	2 F	3	4			1 T	2 F	3	4			1 T	2 F	3	4	
1	☐	☐	☐	☐	_____	26	☐	☐	☐	☐	_____	51	☐	☐	☐	☐	_____
2	☐	☐	☐	☐	_____	27	☐	☐	☐	☐	_____	52	☐	☐	☐	☐	_____
3	☐	☐	☐	☐	_____	28	☐	☐	☐	☐	_____	53	☐	☐	☐	☐	_____
4	☐	☐	☐	☐	_____	29	☐	☐	☐	☐	_____	54	☐	☐	☐	☐	_____
5	☐	☐	☐	☐	_____	30	☐	☐	☐	☐	_____	55	☐	☐	☐	☐	_____
6	☐	☐	☐	☐	_____	31	☐	☐	☐	☐	_____	56	☐	☐	☐	☐	_____
7	☐	☐	☐	☐	_____	32	☐	☐	☐	☐	_____	57	☐	☐	☐	☐	_____
8	☐	☐	☐	☐	_____	33	☐	☐	☐	☐	_____	58	☐	☐	☐	☐	_____
9	☐	☐	☐	☐	_____	34	☐	☐	☐	☐	_____	59	☐	☐	☐	☐	_____
10	☐	☐	☐	☐	_____	35	☐	☐	☐	☐	_____	60	☐	☐	☐	☐	_____
11	☐	☐	☐	☐	_____	36	☐	☐	☐	☐	_____	61	☐	☐	☐	☐	_____
12	☐	☐	☐	☐	_____	37	☐	☐	☐	☐	_____	62	☐	☐	☐	☐	_____
13	☐	☐	☐	☐	_____	38	☐	☐	☐	☐	_____	63	☐	☐	☐	☐	_____
14	☐	☐	☐	☐	_____	39	☐	☐	☐	☐	_____	64	☐	☐	☐	☐	_____
15	☐	☐	☐	☐	_____	40	☐	☐	☐	☐	_____	65	☐	☐	☐	☐	_____
16	☐	☐	☐	☐	_____	41	☐	☐	☐	☐	_____	66	☐	☐	☐	☐	_____
17	☐	☐	☐	☐	_____	42	☐	☐	☐	☐	_____	67	☐	☐	☐	☐	_____
18	☐	☐	☐	☐	_____	43	☐	☐	☐	☐	_____	68	☐	☐	☐	☐	_____
19	☐	☐	☐	☐	_____	44	☐	☐	☐	☐	_____	69	☐	☐	☐	☐	_____
20	☐	☐	☐	☐	_____	45	☐	☐	☐	☐	_____	70	☐	☐	☐	☐	_____
21	☐	☐	☐	☐	_____	46	☐	☐	☐	☐	_____	71	☐	☐	☐	☐	_____
22	☐	☐	☐	☐	_____	47	☐	☐	☐	☐	_____	72	☐	☐	☐	☐	_____
23	☐	☐	☐	☐	_____	48	☐	☐	☐	☐	_____	73	☐	☐	☐	☐	_____
24	☐	☐	☐	☐	_____	49	☐	☐	☐	☐	_____	74	☐	☐	☐	☐	_____
25	☐	☐	☐	☐	_____	50	☐	☐	☐	☐	_____	75	☐	☐	☐	☐	_____

PRINT OR TYPE

RTM/NRCC AEROGRAPHER'S MATE THIRD CLASS
NAVEDTRA 10369

NAME ______________________________ ADDRESS ______________________________
Last First Middle Street/Ship/Unit/Division, etc.

____
City or FPO State Zip

RANK/RATE ________ SOC. SEC. NO. ____________________ DESIGNATOR ________ ASSIGNMENT NO. ________

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE OTHER (Specify) ________________ DATE MAILED ________

SCORE

No.	1 T	2 F	3	4		No.	1 T	2 F	3	4		No.	1 T	2 F	3	4	
1	☐	☐	☐	☐	_____	26	☐	☐	☐	☐	_____	51	☐	☐	☐	☐	_____
2	☐	☐	☐	☐	_____	27	☐	☐	☐	☐	_____	52	☐	☐	☐	☐	_____
3	☐	☐	☐	☐	_____	28	☐	☐	☐	☐	_____	53	☐	☐	☐	☐	_____
4	☐	☐	☐	☐	_____	29	☐	☐	☐	☐	_____	54	☐	☐	☐	☐	_____
5	☐	☐	☐	☐	_____	30	☐	☐	☐	☐	_____	55	☐	☐	☐	☐	_____
6	☐	☐	☐	☐	_____	31	☐	☐	☐	☐	_____	56	☐	☐	☐	☐	_____
7	☐	☐	☐	☐	_____	32	☐	☐	☐	☐	_____	57	☐	☐	☐	☐	_____
8	☐	☐	☐	☐	_____	33	☐	☐	☐	☐	_____	58	☐	☐	☐	☐	_____
9	☐	☐	☐	☐	_____	34	☐	☐	☐	☐	_____	59	☐	☐	☐	☐	_____
10	☐	☐	☐	☐	_____	35	☐	☐	☐	☐	_____	60	☐	☐	☐	☐	_____
11	☐	☐	☐	☐	_____	36	☐	☐	☐	☐	_____	61	☐	☐	☐	☐	_____
12	☐	☐	☐	☐	_____	37	☐	☐	☐	☐	_____	62	☐	☐	☐	☐	_____
13	☐	☐	☐	☐	_____	38	☐	☐	☐	☐	_____	63	☐	☐	☐	☐	_____
14	☐	☐	☐	☐	_____	39	☐	☐	☐	☐	_____	64	☐	☐	☐	☐	_____
15	☐	☐	☐	☐	_____	40	☐	☐	☐	☐	_____	65	☐	☐	☐	☐	_____
16	☐	☐	☐	☐	_____	41	☐	☐	☐	☐	_____	66	☐	☐	☐	☐	_____
17	☐	☐	☐	☐	_____	42	☐	☐	☐	☐	_____	67	☐	☐	☐	☐	_____
18	☐	☐	☐	☐	_____	43	☐	☐	☐	☐	_____	68	☐	☐	☐	☐	_____
19	☐	☐	☐	☐	_____	44	☐	☐	☐	☐	_____	69	☐	☐	☐	☐	_____
20	☐	☐	☐	☐	_____	45	☐	☐	☐	☐	_____	70	☐	☐	☐	☐	_____
21	☐	☐	☐	☐	_____	46	☐	☐	☐	☐	_____	71	☐	☐	☐	☐	_____
22	☐	☐	☐	☐	_____	47	☐	☐	☐	☐	_____	72	☐	☐	☐	☐	_____
23	☐	☐	☐	☐	_____	48	☐	☐	☐	☐	_____	73	☐	☐	☐	☐	_____
24	☐	☐	☐	☐	_____	49	☐	☐	☐	☐	_____	74	☐	☐	☐	☐	_____
25	☐	☐	☐	☐	_____	50	☐	☐	☐	☐	_____	75	☐	☐	☐	☐	_____

PRINT OR TYPE

RTM/NRCC AEROGRAPHER'S MATE THIRD CLASS
NAVEDTRA 10369

NAME ______________________________ ADDRESS ______________________________
Last First Middle Street/Ship/Unit/Division, etc.

____
City or FPO State Zip

RANK/RATE ________ SOC. SEC. NO. ______________ DESIGNATOR ________ ASSIGNMENT NO. ________

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE OTHER (Specify) ______________ DATE MAILED ________

SCORE

	1 T	2 F	3	4			1 T	2 F	3	4			1 T	2 F	3	4	
1	☐	☐	☐	☐	_____	26	☐	☐	☐	☐	_____	51	☐	☐	☐	☐	_____
2	☐	☐	☐	☐	_____	27	☐	☐	☐	☐	_____	52	☐	☐	☐	☐	_____
3	☐	☐	☐	☐	_____	28	☐	☐	☐	☐	_____	53	☐	☐	☐	☐	_____
4	☐	☐	☐	☐	_____	29	☐	☐	☐	☐	_____	54	☐	☐	☐	☐	_____
5	☐	☐	☐	☐	_____	30	☐	☐	☐	☐	_____	55	☐	☐	☐	☐	_____
6	☐	☐	☐	☐	_____	31	☐	☐	☐	☐	_____	56	☐	☐	☐	☐	_____
7	☐	☐	☐	☐	_____	32	☐	☐	☐	☐	_____	57	☐	☐	☐	☐	_____
8	☐	☐	☐	☐	_____	33	☐	☐	☐	☐	_____	58	☐	☐	☐	☐	_____
9	☐	☐	☐	☐	_____	34	☐	☐	☐	☐	_____	59	☐	☐	☐	☐	_____
10	☐	☐	☐	☐	_____	35	☐	☐	☐	☐	_____	60	☐	☐	☐	☐	_____
11	☐	☐	☐	☐	_____	36	☐	☐	☐	☐	_____	61	☐	☐	☐	☐	_____
12	☐	☐	☐	☐	_____	37	☐	☐	☐	☐	_____	62	☐	☐	☐	☐	_____
13	☐	☐	☐	☐	_____	38	☐	☐	☐	☐	_____	63	☐	☐	☐	☐	_____
14	☐	☐	☐	☐	_____	39	☐	☐	☐	☐	_____	64	☐	☐	☐	☐	_____
15	☐	☐	☐	☐	_____	40	☐	☐	☐	☐	_____	65	☐	☐	☐	☐	_____
16	☐	☐	☐	☐	_____	41	☐	☐	☐	☐	_____	66	☐	☐	☐	☐	_____
17	☐	☐	☐	☐	_____	42	☐	☐	☐	☐	_____	67	☐	☐	☐	☐	_____
18	☐	☐	☐	☐	_____	43	☐	☐	☐	☐	_____	68	☐	☐	☐	☐	_____
19	☐	☐	☐	☐	_____	44	☐	☐	☐	☐	_____	69	☐	☐	☐	☐	_____
20	☐	☐	☐	☐	_____	45	☐	☐	☐	☐	_____	70	☐	☐	☐	☐	_____
21	☐	☐	☐	☐	_____	46	☐	☐	☐	☐	_____	71	☐	☐	☐	☐	_____
22	☐	☐	☐	☐	_____	47	☐	☐	☐	☐	_____	72	☐	☐	☐	☐	_____
23	☐	☐	☐	☐	_____	48	☐	☐	☐	☐	_____	73	☐	☐	☐	☐	_____
24	☐	☐	☐	☐	_____	49	☐	☐	☐	☐	_____	74	☐	☐	☐	☐	_____
25	☐	☐	☐	☐	_____	50	☐	☐	☐	☐	_____	75	☐	☐	☐	☐	_____